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## NONCHROME FINAL RINSE STUDY

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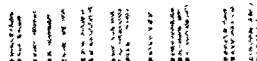
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13. ABSTRACT (Maximum 200 words) This report covers the evaluation of nonchrome final rinse products for the zinc phosphating process. It consists of four phases and was performed under the Environmentally Acceptable Materials, Treatments, and Processes Program, Manufacturing Technology Program The zinc phosphate coating is generally used as a pretreatment of ferrous surfaces to improve the corrosion resistance and adhesion of organic coatings. The final rinse is used as a post treatment to improve the phosphate coating performance. Under this study, the performance of various nonchrome products was evaluated and compared with chrome final rinse products. The various nonchrome products were tested from the standpoint of meeting the current surface finishing performance requirements for ammunition items. The corrosion resistance tests were conducted with test panels and actual production parts coated with army protective finishing systems. The results of this study demonstrated two acceptable nonchrome products. The nonchrome rinse product was successfully proved out in the actual production environment and implemented at the Scranton Army Ammunition Plant. Therefore, it is concluded that the nonchrome final rinse is a viable, environmentally acceptable product for the zinc phosphating process.				
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## **INTRODUCTION**

### **Background**

The Army Manufacturing Technology Program (MANTECH) effort entitled Environmentally Acceptable Materials, Treatments, and Processes (EAMTP) was established to investigate current and emerging technologies in the fields of metal cleaning, pretreatment, organic finishing, and inorganic finishing that would reduce or eliminate hazardous wastes produced at government or contractor facilities. The emphasis of the effort is placed on modifying current methods of manufacturing army materiel to reduce the generation of pollution at its source. The Army Materiel Command (AMC) Thrust Manager's Office is the lead organization with the Production Base Modernization Activity integrating technical and contractual activities of the MANTECH Thrust. The Armament Research, Development and Engineering Center (ARDEC) Heavy Armament Producibility Branch of the Close Combat Armament Center is providing technical support in the areas of metal pretreatment and coatings for munitions metal parts in conjunction with the Belvoir Research Development and Engineering Center (BRDEC) and the Army Material Technology Laboratory (MTL).

### **Zinc Phosphate Coating**

The zinc phosphate coating is one of the most widely used metal pretreatment technologies and is used extensively by the military for the preparation of ferrous materials prior to painting. The army generally used the zinc phosphating process to improve the corrosion resistance and adhesion of their organic coatings. Increasingly stringent environmental regulations have forced manufacturers to reconsider their surface pretreatment processes and waste streams. Efforts to develop finishing systems that do not rely on a pretreatment have not demonstrated comparable performance. Therefore, the focus has been on reducing or eliminating the wastes produced by the zinc phosphating process.

### **Pretreatment Requirements**

The current technical data package (TDP) for the metal parts used in large caliber artillery projectiles requires a pretreatment in accordance with Federal Specification TT-C-490. The Type I process of TT-C-490, spray zinc phosphate coating, is typically required as a pretreatment prior to painting. After pretreatment and painting, the salt spray resistance is tested in accordance with ASTM-B-117.

Paragraph 3.4.5.1 of TT-C-490 requires a chromic acid solution as a final rinse for the Type I coating. Nonchromic acid or chromic/phosphoric final rinses (acid based) are permitted provided the performance test requirements are met. A nonacidulated nonchromic final rinse is not permitted under the current requirement.

## **Zinc Phosphating Process**

The zinc phosphating process typically consists of five basic steps: cleaning the contaminants on metal parts surface; rinsing the cleaning solution from the parts; treating with a phosphating solution; rinsing the excess phosphate solution from the parts; and final rinsing with a chromic acid solution (post treatment). Hexavalent chromium is the most toxic constituent of the zinc phosphating waste. Hexavalent chromium is applied as a final rinse to remove unreacted phosphate salts and to improve corrosion resistance. Removal and disposal of the chrome from the process waste water has become increasingly expensive. Alternate nonchrome bearing final rinses have been available for some time; however, their performance compared to the chrome final rinses has been questionable. Recent formulations have claimed comparable performance to the chrome final rinses.

## **Purpose and Project Description**

The objective of this project was to eliminate one source of chrome contamination at government and contractor facilities by substituting a nonchromium bearing final rinse for a chromium based final rinse in the zinc phosphating process. It was the intent of this study to identify several sources of supply for nonchrome final rinse and to test their level of effectiveness on production items against a series of controls using the chrome based final rinse materials. Once the technology has been proved out on production equipment at the production rate, this new process will be integrated into the Army production base. The entire study consisted of the four following phases:

- Phase I - Industry Survey and Feasibility Test
- Phase II - Laboratory Test
- Phase III - Production Trial Test
- Phase III - Implementation

The purpose of the first phase was to identify various nonchrome rinse products for the zinc phosphating process, and to conduct a cursory testing with a nonchrome

product to validate the anticipated performance prior to a full scale laboratory testing. The second phase was designed to demonstrate technical feasibility of several non-chrome based products under the laboratory environment with the typical army protective coating systems. Phase III was designed to process and test the ammunition metal parts in the actual production environment to demonstrate corrosion protection equivalent to chrome based final rinses using a nonchrome based final rinse. The final phase consisted of the implementation of nonchrome rinse operation at the army ammunition metal parts manufacturing site.

## **PHASE I, INDUSTRY SURVEY AND FEASIBILITY TESTING**

### **Industry Survey**

During the initial investigation into the feasibility of using a nonchrome based product as a final rinse for zinc phosphating army materiel, major chemical manufacturers were contacted to supply product information and any supporting test data that would assist in selecting their nonchrome rinse product for later evaluation. Several ammunition manufacturing facilities were also contacted and questioned regarding the potential use of a nonchrome final rinse. The response from the manufacturers was that a nonchrome final rinse, if comparable in performance to chrome final rinses, would alleviate one hazardous waste stream in their facility, thereby reducing treatment and disposal costs.

### **Feasibility Testing**

An initial cursory feasibility testing was also conducted with one of the non-chrome rinse products. A series of zinc phosphated panels were prepared by Oakite Products Incorporated with the intent of evaluating a nonchrome final rinse versus a chrome final rinse.

### **Process Description**

The phosphate process used for this feasibility testing is outlined in table 1.

## Test Sample Preparation

A total of 18 zinc phosphated steel panels (4 in. X 6 in.) were prepared for the demonstration. Nine panels received the nonchrome final rinse (Oakite Ultra-Rinse) and the balance received the chrome final rinse (Oakite FH 3). All other process steps were identical. The panels were then numerically stamped for identification in preparation for painting.

The panels were then coated with epoxy primer (MIL-P-53022) and alkyd enamel (MIL-E-52891) as described in table 2. The epoxy primer used in this demonstration is certified (on panels) to 336 hours in a 5% salt fog exposure test. Each coating was allowed to flash-off after painting for approximately 10 minutes prior to baking at 200°F for 15 minutes. The panels were then allowed to cool and were measured for dry film thickness at three locations (top, middle, and bottom). The panels receiving a topcoat repeated the process of flash-off, bake, and measurement. The dry film thickness measurements for each coating system are outlined in table 3. The panels were allowed to set for 1 week prior to salt spray testing.

## Test Results

The panels were subjected to a salt spray test in accordance with ASTM B 117. Some samples were scribed prior to the salt spray test. After 600 hours in a salt spray chamber, the final observations were made and are summarized in table 4. The "pass" or "fail" determination was made in accordance with the test criteria established in Federal Specification TT-C-490C which states "no more than 1/8 inch creepage, blistering, or loss of adhesion of the paint from the scribe mark. At all other points there shall be no more than a trace of film failure (ASTM D 610), and not more than 5 scattered blisters none larger than 1 mm (3/64 inch) in diameter on a 4 by 6 inch test panel....".

Both chrome and nonchrome panels appeared to provide comparable levels of corrosion resistance (table 4). Three of five nonchrome panels (1-3, 1-4, and 1-5) coated with epoxy primer and alkyd enamel and three of five chrome treated samples (4-3, 4-4, and 4-5) with the same coating system showed no indication of blistering. The same number of panels (two panels from each group) also had equivalent levels of lifting along the scribe mark. The test panel 5-3 which was post treated with the chrome final rinse failed the 600-hour salt spray test. This sample also had very thin epoxy primer coating in the corroded area which most likely accounted for the inferior performance. A minimum of 0.9 mil is recommended for this epoxy primer.

It appears that the use of the nonchrome final rinse product provided comparable performance after 600 hours of salt spray; therefore, a full scale laboratory testing with several nonchrome products was warranted to confirm the phase I results, to qualify other potential sources, and to evaluate other coating systems.

## **PHASE II, LABORATORY TESTING**

### **Technical Approach**

In light of the initial success of the phase I cursory testing, it was decided to conduct a full scale laboratory test to evaluate nonchrome products and to prove-out the nonchrome final rinses on test panels prior to an actual production demonstration. Four chemical suppliers were contacted to prepare test panels with the nonchrome final rinse and a chrome final rinse to serve as controls. Three of these four chemical companies are current (or previous) suppliers to the existing ammunition metal parts plants. Of the four companies contacted, the following three companies were willing to participate in this study and to demonstrate their products: Oakite, Parker-Amchem, and the third company (hereinafter Company C). The products consist of a variety of chemistries (acidulated, basic/organic based, inorganic based, and polymer based). Participating manufacturers and nonchrome and chrome rinsing products that were used in this test are shown in table 5.

### **Coating Systems**

The standard military paint systems which were selected for preparation of test panels are:

Chemical agent resistant coating (CARC)--This epoxy primer (MIL-P-53022) with polyurethane topcoat (MIL-C-46168) is the Army's all purpose exterior finish which provides decontaminability and excellent corrosion protection, typically in excess of 1000 hours exposure to salt fog.

Epoxy primer (MIL-P-53022)--This coating system is typical of a vehicle interior finish.

Wash prime and alkyd topcoat (DoD-P-15328 and MIL-E-52891 or TT-E-516)--This paint system is standard for a variety of ammunition items.

## **Test Details**

### **Process Description**

The phosphate processes used for the phase II laboratory testing is outlined in tables 6 through 8.

### **Test Sample Preparation**

The standard mild steel "Q" test panels (4 in. X 12 in.) with a standard spray zinc phosphate (in accordance with TT-C-490, Type I) were prepared for this testing. Each vendor pretreated a group of test panels with a chrome final rinse and a second group with a nonchrome based final rinse material. The panels were subsequently painted at the vendors facilities with each of three previously described paint systems.

Approximately 160 panels were phosphated and painted for the study, and eventually 138 were selected for the salt spray evaluation. Nine panels were also selected for a 5000 hour marine atmosphere exposure test and forwarded to Occan City Research Corporation (OCRC), Ocean City, NJ. Each salt spray test panel was identified and recorded. The panels were then waxed along the edges, and their dry film thicknesses were recorded prior to initiating the test. A summary of the salt spray test matrix is provided in table 9. The dry film thickness measurements are outlined in table 10. All film thickness measurements are in thousandths of an inch (mil).

### **Salt Spray Test**

The panels were exposed to a salt fog environment (ASTM B 117) for 600 hours. Periodic evaluations were performed in an attempt to determine when the coating system failed in accordance with the test criteria established in Federal Specification TT-C-490.

## **Marine Atmosphere Exposure Test**

The scribed test panels were exposed to the marine environment for approximately 7 months. The samples were evaluated using the ASTM D 610 and ASTM D 714 methods. At the end of the exposure period, the panels were evaluated by OCRC.

## **Test Results**

### **Salt Spray Test**

The results of the final evaluation of test panels after 600 hours in the salt spray chamber are summarized in table 11. In general, all specimens coated with the CARC or the epoxy primer, using both chrome final rinses and nonchrome final rinses, passed the 600-hour salt fog exposure test.

Two of the nonchrome final rinse products (Oakite and Parker-Amchem) demonstrated comparable performance to the chrome based final rinse with the wash primer and alkyd coating system after a 600-hour exposure. The nonchrome final rinse products (Oakite and Parker-Amchem) coated with wash primer and alkyd passed a 150-hour salt spray exposure as well as the chrome final rinse treated panels (Oakite and Parker Amchem).

The nonchrome final rinse materials coated with wash primer and alkyd, produced by Company C, did not provide comparable performance to the nonchrome final rinses produced by Oakite and Parker Amchem.

The chrome final rinse panels produced by Company C (with the wash prime and alkyd coating system) did not pass the 150-hour mark. These panels were also inferior in appearance when compared to the chrome and nonchrome panels, with wash primer and alkyd topcoat, produced by Oakite and Parker Amchem.

## **Marine Atmosphere Exposure Test**

The Ocean City Research Corporation reported that the nonchrome rinse product appeared to provide comparable performance to the chrome final rinse product after approximately 7 months of exposure.\*

## **PHASE III, PRODUCTION TRIAL TEST**

### **Production Trial Test Site**

Based on successful completion of the phase II effort, a Scope of Work (SOW) was prepared and processed for a production trial test using one of two qualified non-chrome final rinse products. The current ammunition manufacturing sites were also evaluated to select a site for the production trial. The Scranton Army Ammunition Plant (SAAP) was selected as the site for the production trial since the nonchrome final rinse at SAAP would eliminate chrome waste at the facility and preclude the need to operate the chrome treatment portion of the waste treatment system which is exclusively being used for the zinc phosphating line, thereby making the effort cost effective. Scranton AAP is a government-owned, contractor-operated (GOCO) production installation for the metal parts used in large caliber artillery projectiles (e.g., 155 mm and 8-inch). The current operating contractor is Chamberlain Manufacturing Corporation (CMC).

The 155-mm ammunition metal parts fabrication process at SAAP begins with the incoming billet by railroad, cutting mullets of the billet by cold sawing and heating of the mullet in a rotary hearth furnace. The mullets are then forged in three stages: the preform or cabbage stage, the piercing stage, and finally the reverse draw stage. The forging is then rough turned, "nosed" or coined to form the ogive. It is followed by heat treating and quenching in oil. Then the part is hardness tested and finish machined. After finish machining, the part has a base plate welded to its base followed by the application of the rotating band. The finish machined projectile bodies prior to the surface pretreatment operation are shown in figure 1. Finally, the projectile is zinc phosphated (fig. 2), painted (fig. 3), and palletized (fig. 4) for shipment to a load plant.

### **Selection of Nonchrome Product**

Oakite's nonchrome product Ultra-Rinse was selected for the production trial test for the following reasons: it is one of two nonchrome products that demonstrated comparable performance to the chrome rinse product during the phase II tests, and it is compatible with other zinc phosphating chemicals at the production trial site since SAAP uses Oakite products.

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\*Analysis of ARDEC Nonchrome Rinse Marine Atmosphere Exposure Test Panels, prepared for U.S. Army Armament Research, Development and Engineering Center by Ocean City Research Corp., Tennessee Avenue and Beach Thorofare, Ocean City, New Jersey, 1991.

The Oakite Ultra-Rinse is an alkaline solution as opposed to the acid chrome rinse. The product information, including the technical data sheet and the material safety data, is detailed in appendix A.

## **Zinc Phosphating System**

The zinc phosphating operation at SAAP consists of five basic steps: cleaning the contaminants on metal parts surface, rinsing the cleaning solution from the parts, spraying of a phosphating solution, rinsing the excess phosphate solution from the parts, and final rinsing with a chromic acid solution. The effluents generated from this process are continuously treated by the waste treatment system. During this treatment process, the hexavalent chromium from the final rinse stage of the phosphating process is converted to the less toxic trivalent chromium. Further treatment with the addition of lime (flocculation), precipitation, and clarification is also performed. Sludge generated from the clarification process, in the chromate rinse treatment, is sent to the sludge collection and disposal system.

## **Test Details**

The two zinc phosphate process lines, Bonderizer III and Bonderizer II, were used for this test. Bonderizer III operates using the standard chromium bearing final rinse, while Bonderizer II was fitted to apply the nonchrome final rinse. The Ultra-Rinse solution is especially sensitive to chrome; therefore, tank number five had to be completely neutralized of hexavalent chromium and had to be conditioned to an alkaline environment. Also, according to the technical data sheet for the product, fresh water rinses had to be installed (before tank five) to prevent contamination of the non-chrome final rinse stage. The zinc phosphating equipment and procedure at SAAP can be described as follows:

### **Stage I (alkali wash):**

Tank capacity	- 1300 gal.
Spray area length	- 15 ft 6 in.
Time	- 1 min minimum
Chemical	- Oakite SC129
Temperature	- 140 to 180°F
Concentration	- 6 to 20% by volume

Stage II (hot water rinse):

Tank capacity	- 1300 gal.
Spray area length	- 15 ft 6 in.
Time	- 1 min minimum
Chemical	- Water
Temperature	- 140 to 180°F

Stage III (zinc phosphate coat):

Tank capacity	- 1250 gal.
Spray area length	- 11 ft 5 in.
Time	- 1 min minimum
Chemical	- Oakite Cryscoat LWT
Temperature	- 130 to 160°F
Concentration	- 2 to 4% by volume

Stage IV (cold water rinse):

Tank capacity	- 750 gal.
Spray area length	- 10 ft 6 in.
Time	- 30 to 60 sec
Chemical	- Water
Temperature	- Ambient

Stage IVa (fresh water spray rinse):

Stage V (nonchrome rinse):

Tank capacity	- 750 gal.
Spray area length	- 10 ft 6 in.
Time	- 30 to 60 sec
Chemical	- Oakite Ultra-Rinse
Temperature	- Ambient to 140°F
Concentration	- 1 to 2% by volume

A picture and schematic of the fresh water rinse are included as appendix B, and the actual operating data for the zinc phosphate coating of test samples are shown in appendix C.

## Test Sample Preparation

Sixty 155-mm M107 projectile bodies without rotating bands were selected and numerically stamped on the bourrelet. After the shells were zinc phosphated, they were painted in accordance with table 12 (standard munitions coating systems). The following two standard military paint systems were selected for the preparation of the test projectiles:

1. Wash prime (DoD-P-15328; 0.3 to 0.5 mil typical) and alkyd topcoat (MIL-E-52891; 0.9 to 1.2 mil typical)--This paint system is standard for a variety of ammunition items.

2. Epoxy primer (MIL-P-53022; 0.9 to 1.2 mil typical) and alkyd topcoat (MIL-E-52891; 0.9 to 1.2 mil typical)--This coating system is currently being used for the 155-mm M864 large caliber artillery projectile.

All projectiles were baked at  $225^{\circ}\text{F} \pm 25^{\circ}\text{F}$  for 30 minutes.

Paint thicknesses were taken on all projectiles using a magnetic thickness gage (table 13).

The phosphate coating weight from each bonderizer was measured in accordance with TT-C-490 and the average weight of three panels is shown in appendix C.

Standard paint adhesion tests were conducted on four projectiles from each bonderizer system in accordance with the test criteria specified in TT-C-490. All test results were determined to be acceptable.

## Test Results

A total of eight test samples (two of each category in table 12) were selected and tested by salt spray exposure for 96 hours in accordance with ASTM B 117 (TDP requirement for the M864 projectile metal parts). After the 96-hour salt spray tests at SAAP, test samples were examined by representatives from ARDEC and CMC (table 14). The test samples after the salt spray testing at SAAP are shown in figures 5 through 12. No blisters were observed on all test samples after 96 hours in the salt spray chamber. Also, all scribe marks were examined and determined to be in excellent condition.

A second group of samples were sent to ARDEC for a comparative salt spray analysis for 500 hours. The test samples were exposed to a salt fog environment in accordance with ASTM B 117. Periodic examinations were conducted in an attempt to determine when the coating system failed in accordance with the test criteria established in Federal Specification TT-C-490 (table 15). The test samples after 500 hours of salt spray testing are shown in figures 13 through 17. All test specimens showed no indication of blistering after 96 hours, thereby confirming SAAP's test results. After 144 hours of testing, it appeared that the nonchrome treated samples coated with wash primer and alkyd enamel performed somewhat better than the chrome control sample. All test samples with the epoxy and alkyd coating system successfully passed the requirement with no noticeable differences.

In summary, the salt spray test and adhesion test results of SAAP and ARDEC tests demonstrated that the nonchromium bearing final rinse solution performed comparably to the standard chromium bearing final rinse in conjunction with the finishing systems employed by SAAP.

## **PHASE IV, IMPLEMENTATION**

### **Scranton Army Ammunition Plant Implementation**

Upon successful completion of the phase III effort, a request from CMC was submitted to the Government Procurement Agency to permit the use of the nonchrome rinse product (Ultra-Rinse) manufactured by Oakite for all three bonderizer systems at the Scranton facility. Based on the recommendation of the technical agency, this request has been formally approved as a cost savings and a method to reduce the generation of hazardous waste and the associated liability of the waste.

Before the implementation of nonchrome rinse, the tank must have the hexavalent chromium neutralized using sulfuric acid and sodium metabisulfite. After verification that the hexavalent chromium has been neutralized, the tank must be pH neutralized by the addition of sodium hydroxide. All of the neutralization rinse waters must then be drained to a chemical waste treatment system. Analysis for pH and conductivity must be made twice daily. When the readings of conductivity exceed the fresh makeup readings by 266 ppm (400 micromhos), the tank must be dumped.

The standard operating procedure (SOP) for the zinc phosphating process at SAAP was also subsequently revised to incorporate the nonchrome final rinse product and was approved.

Since the implementation of the nonchrome final rinse product, SAAP has successfully manufactured over 130,000 projectile metal parts assemblies (as of December 1991).

This successful implementation of the nonchrome final rinse operation was presented to representatives from various government installations and private industries during the AMC Lessons Learned HAZMIN Workshop, Orlando, FL in September 1991.

### **Other Government Installations**

Based on the successful demonstration of the nonchrome final rinse operation for the zinc phosphating operation, the use of a nonchromated final rinse solution for zinc phosphating pretreatment needs to be investigated at all munitions manufacturing facilities as a means to reduce the generation of hazardous waste. Since only one product has been evaluated and qualified at SAAP during the production trial test, additional demonstrations would be necessary to qualify other nonchrome rinse products.

Although the implementation of the nonchrome final rinse into a production setting is a relatively minor change with a minimal cost impact, a nonchrome final rinse product would have to be evaluated for acceptability to each production system with respect to the organic finish, the process parameters, the waste treatment facility, and the environmental constraints. It may require a demonstration test at each production site to confirm that the nonchrome material has no adverse effect on the coating performance before actual implementation. The producer may decide to use a different nonchrome material which has not been demonstrated under this project. In any case, the nonchrome final rinses must be tested and qualified.

The Federal Specification TT-C-490 which covers pretreatments for the organic coating of the ferrous surface was amended to permit a nonacidified and non-chromic final rinse for the phosphating process provided the specific approval of the procurement agency is obtained.

## CONCLUSIONS

The phase I industry survey and evaluation of pertinent information identified potential nonchrome bearing products.

The phase I test results of cursory testing with a nonchrome product inferred that the use of the nonchrome final rinse product appears to provide equivalent performance to the chrome final rinse.

The phase II test results showed that the use of the nonchrome final rinse products provides comparable levels of corrosion resistance after 600 hours of salt spray and 7 months of marine atmosphere exposure to the chrome final rinse.

The two nonchrome final rinse products (Oakite and Parker-Amchem) were qualified under phase II. The nonchrome and chrome products from the third company did not provide comparable performance to the products from Oakite and Parker-Amchem.

The phase III salt spray testing of the actual ammunition metal parts currently employed at SAAP demonstrated that the nonchromium bearing final rinse solution (Oakite product) offers equivalent performance to the standard chromium bearing final rinse.

The phase III results of the ARDEC salt spray test confirmed the SAAP results, and it was also demonstrated that the performance of the nonchromium bearing final rinse on the actual production parts is comparable to the standard chromium bearing final rinse after a 500-hour exposure.

It is concluded that the nonchrome final rinse is a viable, environmentally acceptable product for the zinc phosphating process when using the large caliber ammunition protective coating systems.

## **RECOMMENDATIONS**

In light of the successful demonstration and implementation of the nonchrome rinse product at SAAP, it is recommended that the use of a nonchromated final rinse solution for zinc phosphating pretreatment be investigated at all munitions manufacturing facilities as a means to reduce the generation of hazardous and toxic waste. Each facility would be reviewed on a case-by-case basis as variations in the performance of the pretreatment and finishing systems exist.

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Table 1. Phase I phosphating process description

<u>Stage</u>	<u>Description</u>	<u>Duration (sec)</u>
1	Alkaline cleaner, BP 181, 2 oz/gal.	60
2	Constant overflow water rinse, ambient	20
3	Phosphate Cryscoat LWT, 2.5%	60
4	Constant overflow water rinse, ambient	20
5	Final Rinse Ultra-Rinse 1.5% (non-chrome) or FH3 0.2% (chrome)	10 10
6	Constant overflow water rinse, ambient	20

Table 2. Coated test sample matrix for phase I test

<u>Panel no.</u>	<u>Pretreatment</u>	<u>Coating system</u>
1-1 through 1-5	Nonchrome	Epoxy primer and alkyd top coat
2-1 through 2-4	Nonchrome	Epoxy primer
4-1 through 4-5	Chrome	Epoxy primer and alkyd top coat
5-1 through 5-4	Chrome	Epoxy primer

Table 3. Dry film thickness data for phase I coated samples

<u>Panel no.</u>	<u>Epoxy Primer, mils</u>			<u>Total coating, mils</u>		
	<u>Top</u>	<u>Mid</u>	<u>Bottom</u>	<u>Top</u>	<u>Mid</u>	<u>Bottom</u>
1-1	1.0	0.8	0.6	2.0	2.4	2.2
1-2	1.0	1.0	0.7	2.0	2.2	1.8
1-3	1.0	1.0	0.8	1.6	2.0	2.0
1-4	0.6	0.7	0.8	1.6	1.7	1.8
1-5	0.8	1.0	1.0	1.8	2.0	2.0
2-1	1.8	1.8	1.8			
2-2	1.0	0.9	0.8			
2-3	0.9	1.1	1.2			
2-4	0.9	1.1	1.2			
4-1	0.8	0.8	0.9	2.4	2.6	2.4
4-2	0.9	0.9	0.9	1.9	2.0	2.1
4-3	0.8	0.8	0.8	2.0	2.0	1.7
4-4	0.5	0.7	0.7	1.7	1.7	1.8
4-5	0.7	0.8	0.8	2.0	2.0	1.6
5-1	1.0	1.2	1.4			
5-2	1.0	1.1	1.0			
5-3	0.9	0.9	0.6			
5-4	1.0	1.2	1.5			

Table 4. Phase I test results and observations

<u>Panel</u>	<u>Coating system</u>	<u>Result<sup>a</sup></u>	<u>Special observations</u>
1-1 <sup>b</sup>	NCR, EP/AE	Pass	Acceptable, no detectable blistering, maximum lifting at the scribe 1/16 in., generally 1/32 in.
1-2 <sup>b</sup>	NCR, EP/AE	Pass	See observations for panel 1-1
1-3	NCR, EP/AE	Pass	Acceptable, no blistering of any kind, excellent general condition
1-4	NCR, EP/AE	Pass	See observation for panel 1-3
1-5	NCR, EP/AE	Pass	See observation for panel 1-3
2-1 <sup>b</sup>	NCR, EP	Pass	Acceptable, little rust along scribe, maximum 1/32 in. lifting at the scribe
2-2 <sup>b</sup>	NCR, EP	Pass	See observation for panel 2-1
2-3	NCR, EP	Pass	Acceptable, no blisters, excellent condition
2-4	NCR, EP	Pass	See observation for panel 2-3
4-1 <sup>b</sup>	CR, EP/AE	Pass	Acceptable, less rusting along the scribe than panels 1-1 and 1-2; no detectable blisters, maximum lifting at the scribe 1/16 in.
4-2 <sup>b</sup>	CR, EP/AE	Pass	See observations for panel 4-1
4-3	CR, EP/AE	Pass	See observations for panel 1-3
4-4	CR, EP/AE	Pass	See observations for panel 1-3
4-5	CR, EP/AE	Pass	See observations for panel 1-3
5-1 <sup>b</sup>	CR, EP	Pass	See observation for panel 2-1
5-2 <sup>b</sup>	CR, EP	Pass	See observation for panel 2-1

Table 4. (Continued)

<u>Panel</u>	<u>Coating system</u>	<u>Result</u> <sup>a</sup>	<u>Special observations</u>
5-3	CR, EP	Fail	Unacceptable, 17 blisters in the lower 1/3 portion of the panel; the upper 2/3 portion was acceptable; this particular panel had very thin coating (0.6 mil) in the corroded area that most likely accounted for the below average performance
5-4	CR, EP	Pass	See observation for panel 2-3

NCR = Nonchrome rinse

CR = Chrome rinse

EP = Epoxy prime (MIL-P-53022)

AE = Akryd enamel (MIL-E-52891)

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<sup>a</sup> Based on a 600-hour salt spray test (ASTM B 117) and evaluated in accordance with the test criteria established in Federal Specification TT-C-490.

<sup>b</sup> Scribed panels.

Table 5. Chemical manufacturers and their product names

<u>Manufacturer</u>	<u>Chrome Products</u>	<u>Nonchrome products</u>
Oakite	FH3	Ultra-Rinse
Parker-Amchem	Parcolene 60A Parcolene 8	Parcolene 95
Company C	Chrome	Nonchrome 1 Nonchrome 2 Nonchrome 3

Table 6. Process description for Oakite products

<u>Operation</u>	<u>Description</u>	<u>Duration (sec)</u>
1	Alkaline cleaner, BP 181	60
2	Constant overflow water rinse, ambient	20
3	Phosphate Cryscoat LWT	60
4	Constant overflow water rinse, ambient	20
5	Final rinse: Chrome--FH3 or Nonchrome--Ultra-rinse	10 10
6	Constant overflow water rinse, ambient	20
7	Air dry	180 to 300

Table 7. Process description for Parker-Amchem products

<u>Operation</u>	<u>Description</u>	<u>Duration (sec)</u>
1	PCL 900 cleaner	60
2	Constant overflow water rinse, ambient	30
3	PLN 29 conditioner	30
4	Phosphating: B-910, with accelerator or TD-1423-U	60
5	Constant overflow water rinse, ambient	30
6	Final Rinse: Chrome--Parcolene 60A or Parcolene 8 Nonchrome--Parcolene 95	5
7	Constant overflow DI water rinse, ambient	15
8	Air dry	180 to 300

Table 8. Process description for Company C products

<u>Operation</u>	<u>Description</u>	<u>Duration (sec)</u>
1	Cleaner	60
2	Constant overflow water rinse, 140°F	30
3	Grain refiner	30
4	Phosphating solution at 107°F	60
5	Constant overflow water rinse, ambient	30
6	Final rinse: Chrome, nonchrome 1, 2, or 3	30
7	Constant overflow DI water rinse, ambient	15
8	Air dry	300

Table 9. Coated test sample matrix for phase II test

<u>Vendor</u>	<u>CARC</u>	<u>Epoxy</u>	<u>Wash Prime/Alkyd</u>
Oakite	Chrome rinse Nonchrome	Chrome rinse Nonchrome	Chrome rinse Nonchrome
Parker Amchem	Chrome rinse Nonchrome	Chrome rinse Nonchrome	Chrome rinse Nonchrome
Company C	Chrome rinse Nonchrome 1 Nonchrome 2 Nonchrome 3	Chrome rinse Nonchrome 1 Nonchrome 2 Nonchrome 3	Chrome rinse Nonchrome 1 Nonchrome 2 Nonchrome 3

CARC = Chemical agent resistant coating, epoxy primer  
(MIL-P-53022) with polyurethane topcoat (MIL-C-46168)

Epoxy prime = MIL-P-53022

Wash prime = DoD-P-15328

Alkyd = MIL-E-52891 or TT-E-516

Table 10. Dry film thickness data for phase II test panels

Set no.	Coating system	<u>Panel 1</u>		<u>Panel 2</u>		<u>Panel 3</u>		<u>Panel 4</u>		<u>Panel 5</u>	
		<u>Scribed</u>		<u>Scribed</u>		<u>Unscribed</u>		<u>Unscribed</u>		<u>Unscribed</u>	
		<u>EP</u>	<u>TC</u>	<u>EP</u>	<u>TC</u>	<u>EP</u>	<u>TC</u>	<u>EP</u>	<u>TC</u>	<u>EP</u>	<u>TC</u>
1	CARC	1.0	2.0	1.0	2.2	1.0	1.6	0.6	1.6	0.8	1.8
		0.8	2.4	1.0	2.2	1.0	2.0	0.7	1.7	1.0	2.0
		0.6	2.2	0.7	1.8	0.8	2.0	0.8	1.8	1.0	2.0
2	EP	1.8		1.0		0.9		0.9		---	
		1.8		0.9		1.1		1.1		---	
		1.8		0.8		1.2		1.2		---	
4	CARC	0.8	2.4	0.9	1.9	0.8	2.0	0.5	1.7	0.7	2.0
		0.8	2.6	0.9	2.0	0.8	2.0	0.7	1.7	0.8	2.0
		0.9	2.4	0.9	2.1	0.8	1.7	0.7	1.8	0.8	1.6
5	EP	1.0		1.0		0.9		1.0		---	
		1.2		1.1		0.9		1.2		---	
		1.4		1.0		0.6		1.5		---	
7	CARC		1.5		2.8		3.1		3.1		2.9
			2.5		3.1		3.0		3.2		2.9
			2.7		3.2		3.1		2.9		3.2
			2.4		3.0		2.8		3.0		3.5
8	EP	1.0		1.0		1.0		1.3		1.2	
		1.2		1.1		1.2		1.4		1.4	
		1.0		1.2		1.2		1.3		1.1	
		0.9		1.2		1.1		1.2		1.1	
9	WP/AE		0.9		0.9		1.2		1.2		1.2
			1.0		1.0		1.1		1.3		1.4
			0.9		1.0		1.3		1.3		1.4
			1.0		1.0		1.2		1.2		1.5
10	CARC		3.0		2.8		2.9		3.1		3.2
			3.3		3.0		3.7		3.2		3.5
			3.1		3.1		3.4		3.5		3.2
			3.2		3.1		2.9		3.2		3.4
11	EP	1.0		1.2		1.0		1.0		1.0	
		1.0		1.2		1.1		1.1		1.3	
		1.2		1.3		1.0		1.0		1.1	
		1.1		1.1		1.2		1.2		1.2	

Table 10. (Continued)

Set no.	Coating system	<u>Panel 1</u>		<u>Panel 2</u>		<u>Panel 3</u>		<u>Panel 4</u>		<u>Panel 5</u>	
		<u>Scribed</u>		<u>Scribed</u>		<u>Unscribed</u>		<u>Unscribed</u>		<u>Unscribed</u>	
		<u>EP</u>	<u>TC</u>	<u>EP</u>	<u>TC</u>	<u>EP</u>	<u>TC</u>	<u>EP</u>	<u>TC</u>	<u>EP</u>	<u>TC</u>
12	WP/AE		1.2		1.3		1.1		1.2		1.3
			1.2		1.3		1.3		1.3		1.3
			1.1		1.2		1.4		1.3		1.6
			1.2		1.2		1.5		1.4		1.6
13	CARC		3.7		3.2		3.1		2.9		3.2
			3.0		3.3		3.1		2.9		3.4
			3.0		2.9		3.1		2.9		2.8
			3.3		2.7		3.3		3.0		3.2
14	EP	1.7		1.7		1.6		1.7		2.3	
		1.6		1.7		1.9		1.7		1.6	
		1.9		1.6		1.5		1.7		2.1	
		1.8		1.5		1.5		1.8		2.0	
15	WP/AE		0.7		0.7		1.2		0.9		1.4
			1.1		1.0		0.7		0.7		0.9
			1.0		1.0		0.9		1.1		0.7
			1.1		1.0		1.0		0.9		1.0
16	CARC		3.1		3.1		2.7		3.1		3.6
			3.5		3.3		3.1		3.1		2.8
			3.3		3.1		3.2		3.3		2.7
			3.5		3.6		3.1		3.2		3.3
17	EP	1.3		1.8		2.0		1.6		1.7	
		1.1		1.5		1.9		1.7		1.6	
		1.5		1.3		1.9		1.9		1.4	
		1.1		1.5		1.7		1.6		1.5	
18	WP/AE		0.8		1.1		0.8		1.1		1.2
			0.9		1.0		1.0		0.9		1.0
			0.8		0.8		1.1		1.1		1.1
			0.9		0.8		0.9		1.1		1.0
19	CARC		5.8		5.6		6.8		5.8		4.0
			6.3		6.0		6.2		5.7		5.7
			6.9		6.2		5.4		6.0		3.5
			5.2		6.5		5.9		6.3		4.5

Table 10. (Continued)

Set no.	Coating system	<u>Panel 1</u>		<u>Panel 2</u>		<u>Panel 3</u>		<u>Panel 4</u>		<u>Panel 5</u>	
		<u>Scribed</u>		<u>Scribed</u>		<u>Unscribed</u>		<u>Unscribed</u>		<u>Unscribed</u>	
		<u>EP</u>	<u>TC</u>	<u>EP</u>	<u>TC</u>	<u>EP</u>	<u>TC</u>	<u>EP</u>	<u>TC</u>	<u>EP</u>	<u>TC</u>
20	EP	1.2		1.6		1.5		1.9		2.1	
		1.5		1.4		1.3		1.7		1.8	
		1.3		1.5		1.7		2.0		1.7	
		1.4		1.4		2.0		1.9		1.7	
21	WP/AE		1.1		0.9		1.1		0.8		1.0
			1.0		1.0		1.3		0.7		1.0
			1.2		1.0		1.3		0.9		1.3
			1.0		1.7		1.3		0.8		0.9
22	CARC		2.7		2.9		3.0		2.8		2.9
			2.9		3.1		3.0		3.3		3.2
			3.1		2.6		3.3		2.9		3.2
			2.8		2.8		3.2		3.2		3.6
23	EP	2.1		2.8		1.7		1.7		1.7	
		2.2		1.4		1.8		1.4		0.8	
		2.1		2.0		1.4		1.5		1.5	
		1.6		1.7		1.6		1.9		1.6	
24 *	WP/AE		1.2		1.1		1.1		1.2		1.3
			1.0		1.1		0.8		1.2		1.0
			1.3		1.1		0.8		1.0		1.2
			1.1		1.2		1.0		0.9		1.0

CARC = Chemical agent resistant coating

EP = Epoxy prime (MIL-P-53022)

AE = Alkyd enamel (MIL-E-52891)

TC = Total coating thickness

Table 11. Phase II test panel description and test results

<u>Set no.</u>	<u>Pretreatment</u>	<u>Vendor</u>	<u>Test results</u> <u>(hr)</u>
1 and 2	Nonchrome	Oakite	Passed 600
4 and 5	Chrome	Oakite	Passed 600
7 and 8	Chrome	Parker-Amchem	Passed 600
9	Chrome	Parker-Amchem	Passed 150
10 and 11	Nonchrome	Parker-Amchem	Passed 600
12	Nonchrome	Parker-Amchem	Passed 150
13 and 14	Chrome	Company C	Passed 600
15 (note 1)	Chrome	Company C	Failed 150
16 and 17	Nonchrome 1	Company C	Passed 600
18	Nonchrome 1	Company C	Failed 150
19 and 20	Nonchrome 2	Company C	Passed 600
21	Nonchrome 2	Company C	(note 2)
22 and 23	Nonchrome 3	Company C	Passed 600 hours
24	Nonchrome 3	Company C	(note 3)

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Note 1: Panel 5 of set 15 was not tested.

Note 2: Panels 1 and 2 of set 21 passed 150 hr; panels 3 through 5 failed 150 hr.

Note 3: Panel 4 of set 24 failed 150 hr.

Table 12. Coated test sample matrix for phase III test

<u>Sample no.</u>	<u>Pretreatment</u>	<u>Coating system</u>
21 through 30	Chrome	Wash primer and alkyd top coat
31 through 40	Nonchrome	Wash primer and alkyd top coat
41 through 50	Chrome	Epoxy primer and alkyd top coat
51 through 60	Nonchrome	Epoxy primer and alkyd top coat

Table 13. Dry film thickness range for phase III test samples

<u>Group Projectile Number</u>	<u>Total mil</u>
21 to 30	1.05 to 1.10
31 to 40	1.15 to 1.25
41 to 50	1.9 to 2.0
51 to 60	1.8 to 2.0

Table 14. Phase III salt spray test results at SAAP<sup>a</sup>

<u>Sample</u>	<u>Category</u>	<u>DFT<sup>b</sup> (mil)</u>	<u>Figure</u>
21	Chrome rinse, wash primer and alkyd paint	1.10	2
22	chrome rinse, wash primer and alkyd paint	1.05	3
31	Nonchrome rinse, wash primer and alkyd paint	1.25	4
35	Nonchrome rinse, wash primer and alkyd paint	1.15	5
48	Chrome rinse, epoxy primer and alkyd paint	2.00	6
49	Chrome rinse, epoxy primer and alkyd paint	1.90	7
54	Nonchrome rinse, epoxy primer and alkyd paint	1.80	8
56	Nonchrome rinse, epoxy primer and alkyd paint	2.00	9

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<sup>a</sup> No blisters, pass

<sup>b</sup> Dry Film Thickness (DFT)

Table 15. Phase III salt spray test results at ARDEC

<u>Sample</u>	<u>Category</u>	<u>Test Duration (hr)</u>	<u>Remarks</u>
28	Chrome rinse, wash primer/alkyd paint	96	No blisters, pass
32	Nonchrome rinse, wash primer/alkyd paint	96	No blisters, pass
36	Nonchrome rinse, wash primer/alkyd paint	96	No blisters, pass
47	Chrome rinse, epoxy primer/alkyd paint	96	No blisters, pass
51	Nonchrome rinse, epoxy primer/alkyd paint	96	No blisters, pass
28	Chrome rinse, wash primer/alkyd paint	144	3 blisters, marginal
32	Nonchrome rinse, wash primer/alkyd paint	144	1 blister, pass
36	Nonchrome rinse, wash primer/alkyd paint	144	1 blister, pass
47	Chrome rinse, epoxy primer/alkyd paint	144	No blisters, pass
51	Nonchrome rinse, epoxy primer/alkyd paint	144	No blisters, pass
28	Chrome rinse, wash primer/alkyd paint	240	Multiple blisters, fail
32	Nonchrome rinse, wash primer/alkyd paint	240	2 blisters, pass
36	Nonchrome rinse, wash primer/alkyd paint	240	Multiple blisters, fail
47	Chrome rinse, epoxy primer/alkyd paint	240	No blisters, pass
51	Nonchrome rinse, epoxy primer/alkyd paint	240	No blisters, pass
28	Chrome rinse, wash primer/alkyd paint	500	Multiple blisters, fail
32	Nonchrome rinse, wash primer/alkyd paint	500	Multiple blisters, fail
36	Nonchrome rinse, wash primer/alkyd paint	500	Multiple blisters, fail
47	Chrome rinse, epoxy primer/alkyd paint	500	Pass
51	Nonchrome rinse, epoxy primer/alkyd paint	500	Pass

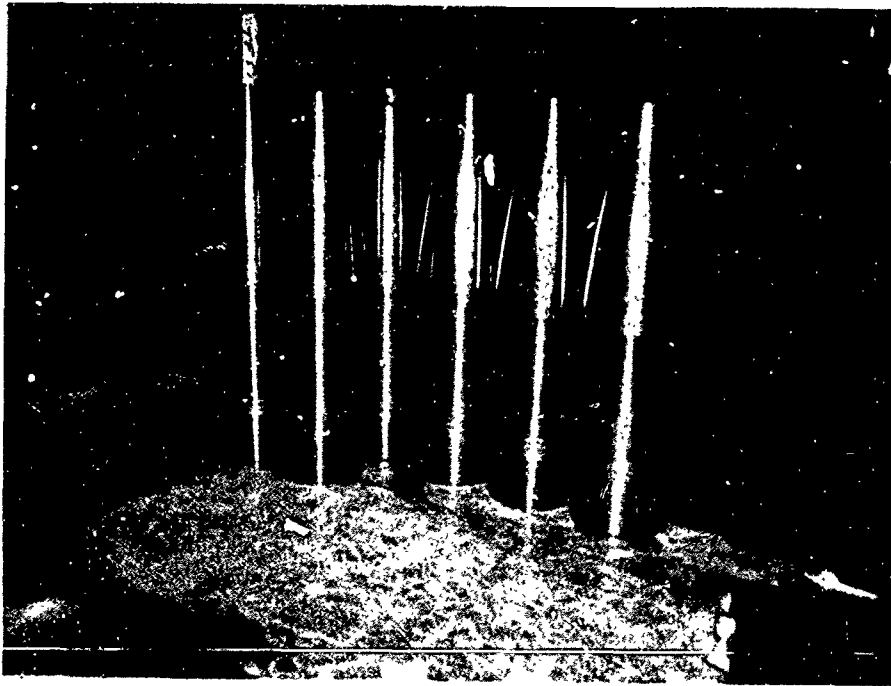


Figure 1. Finish machined projectile metal parts assemblies

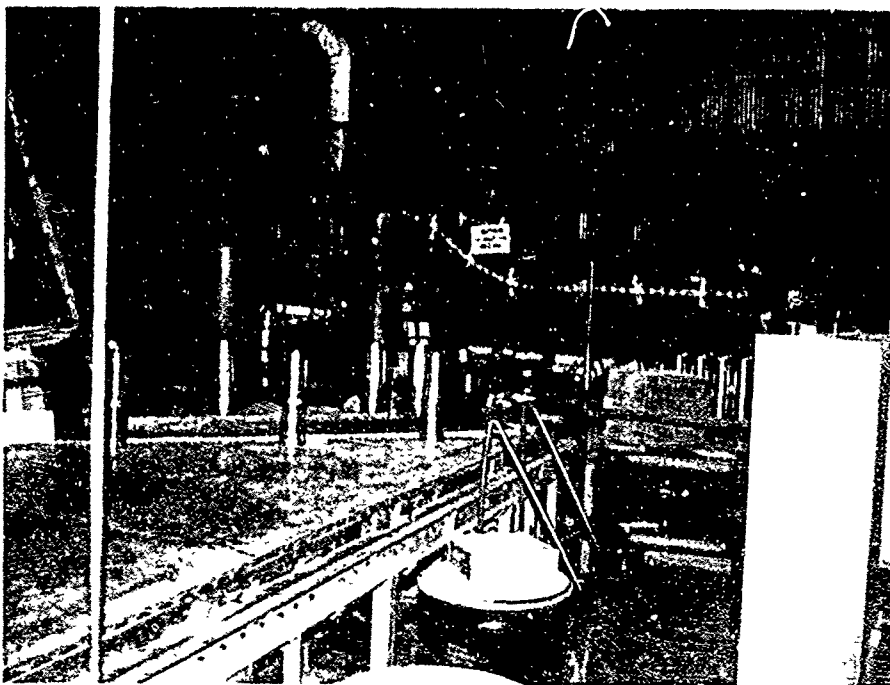


Figure 2. Zinc phosphating line



Figure 3. Painting operation

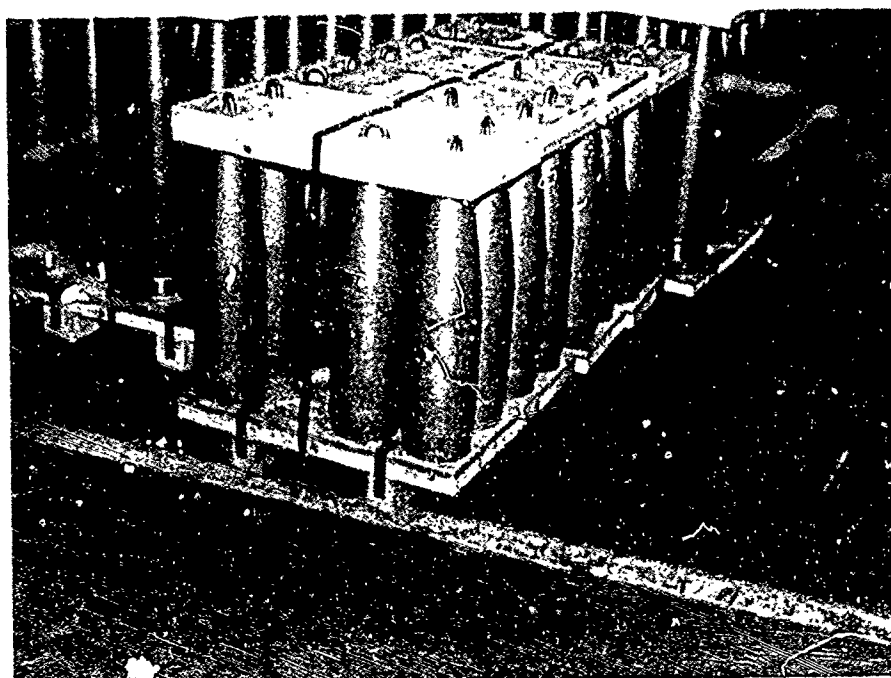


Figure 4. Palletized projectile metal parts assemblies

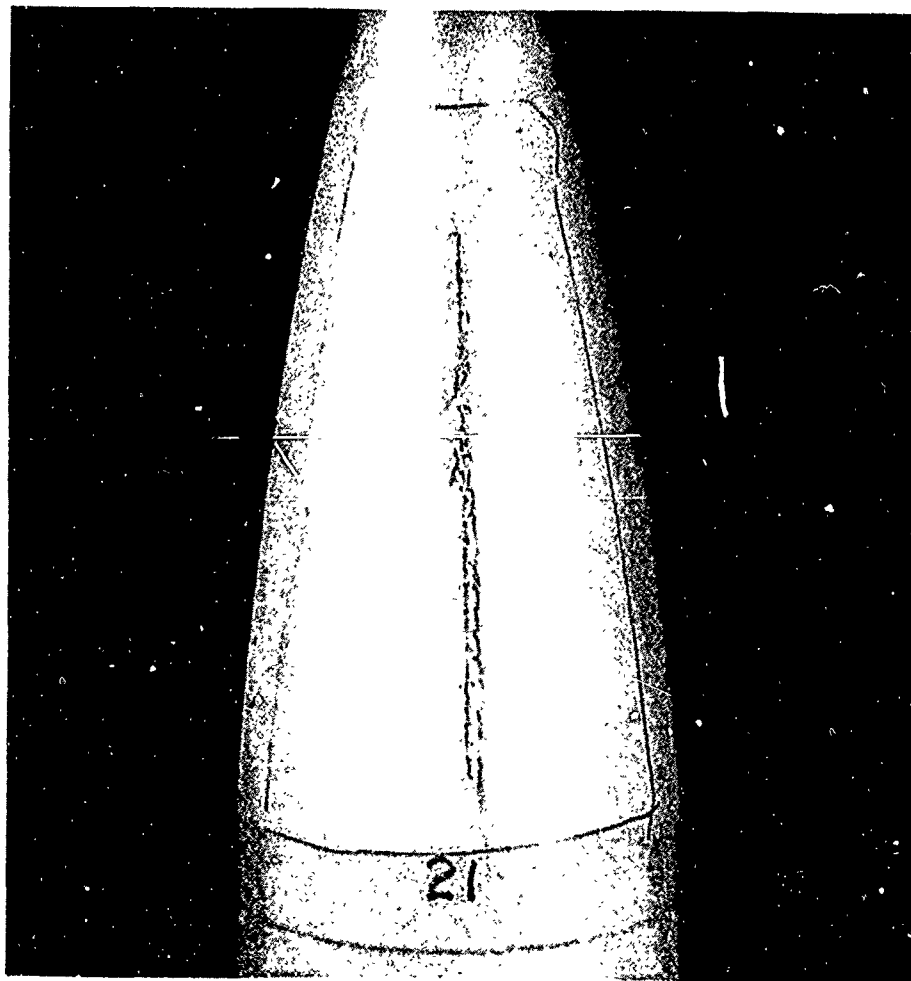


Figure 5. SAAP test sample 21; coating: CR/WP/AE

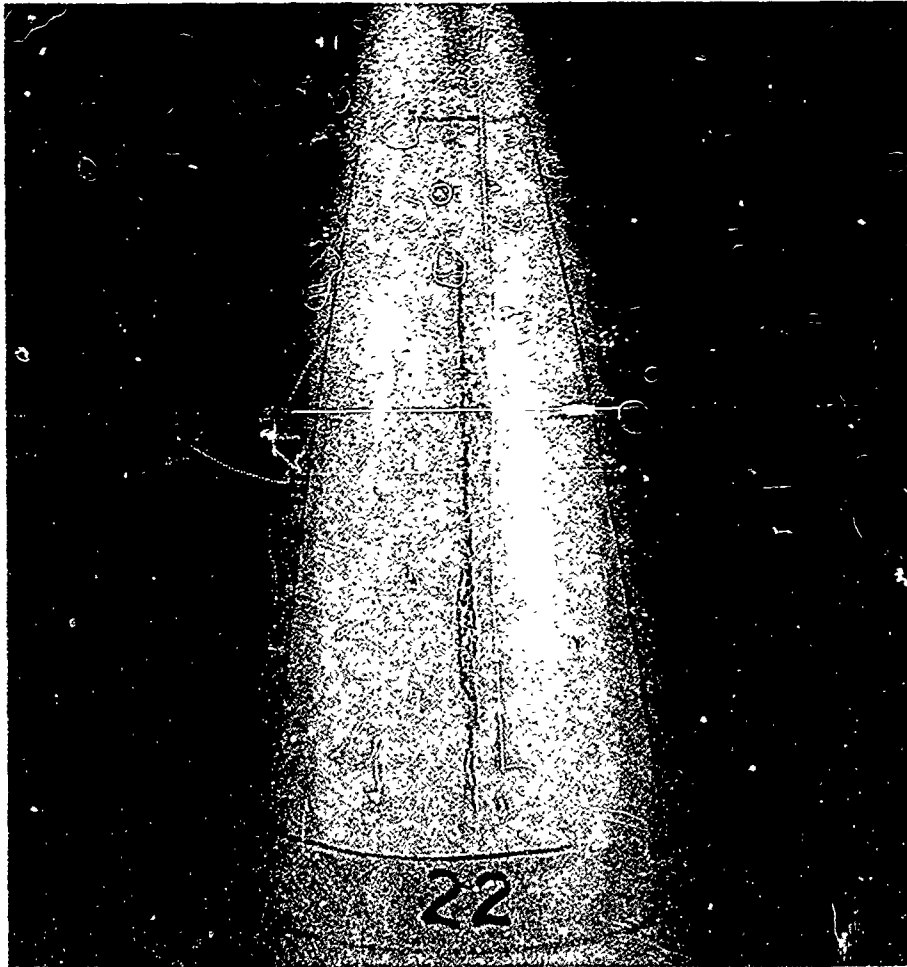


Figure 6. SAAP test sample 22; coating: CR/WP/AE

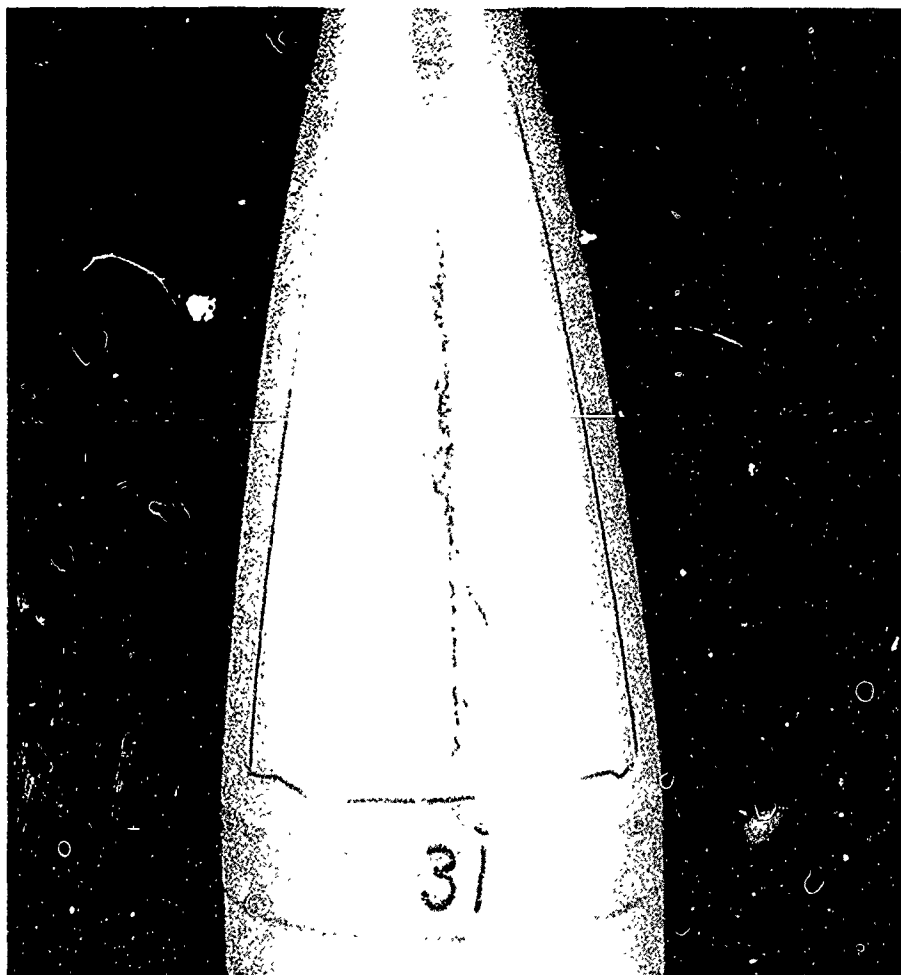


Figure 7. SAAP test sample 31; coating: NCR/WP/AE

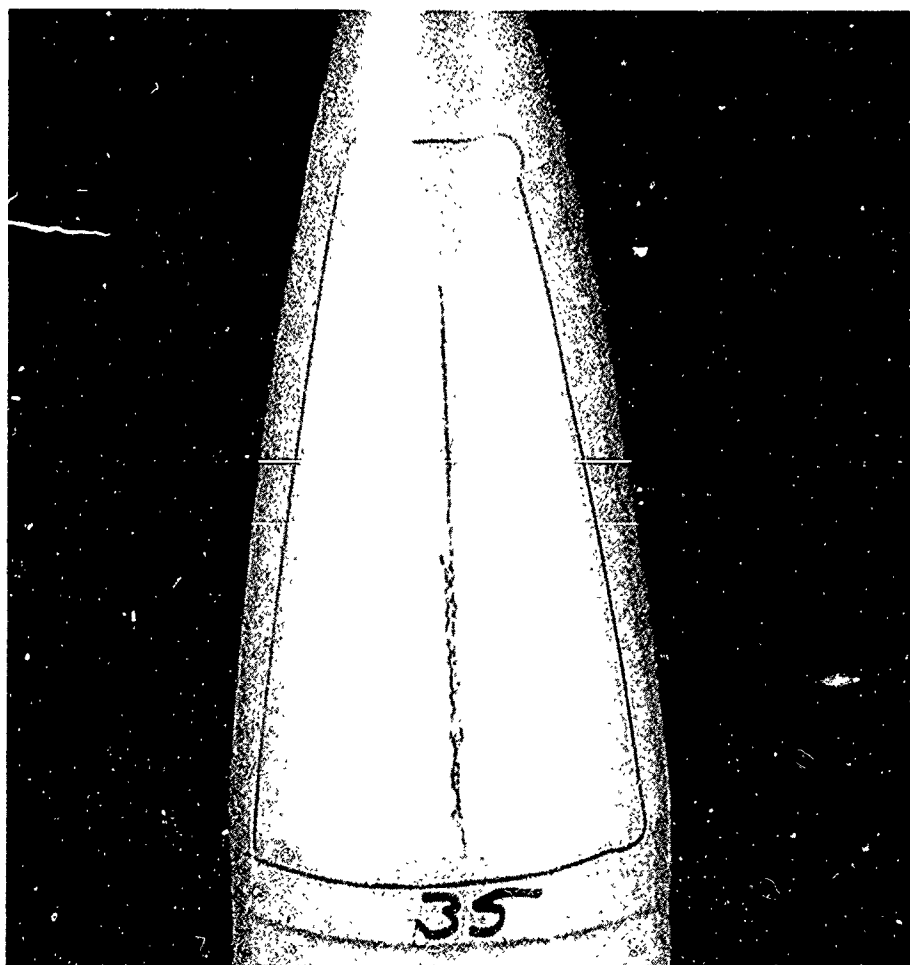


Figure 8. SAAP test sample 35; coating: NCR/WP/AE

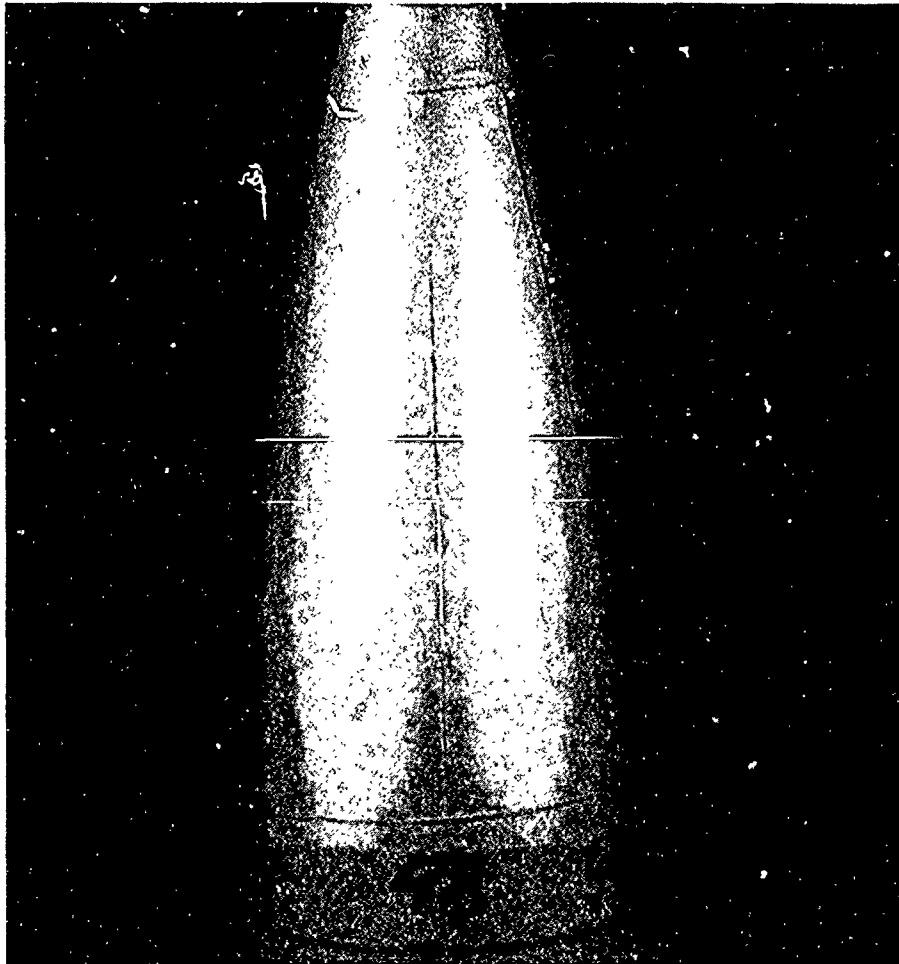


Figure 9. SAAP test sample 48; coating: CR/EP/AE

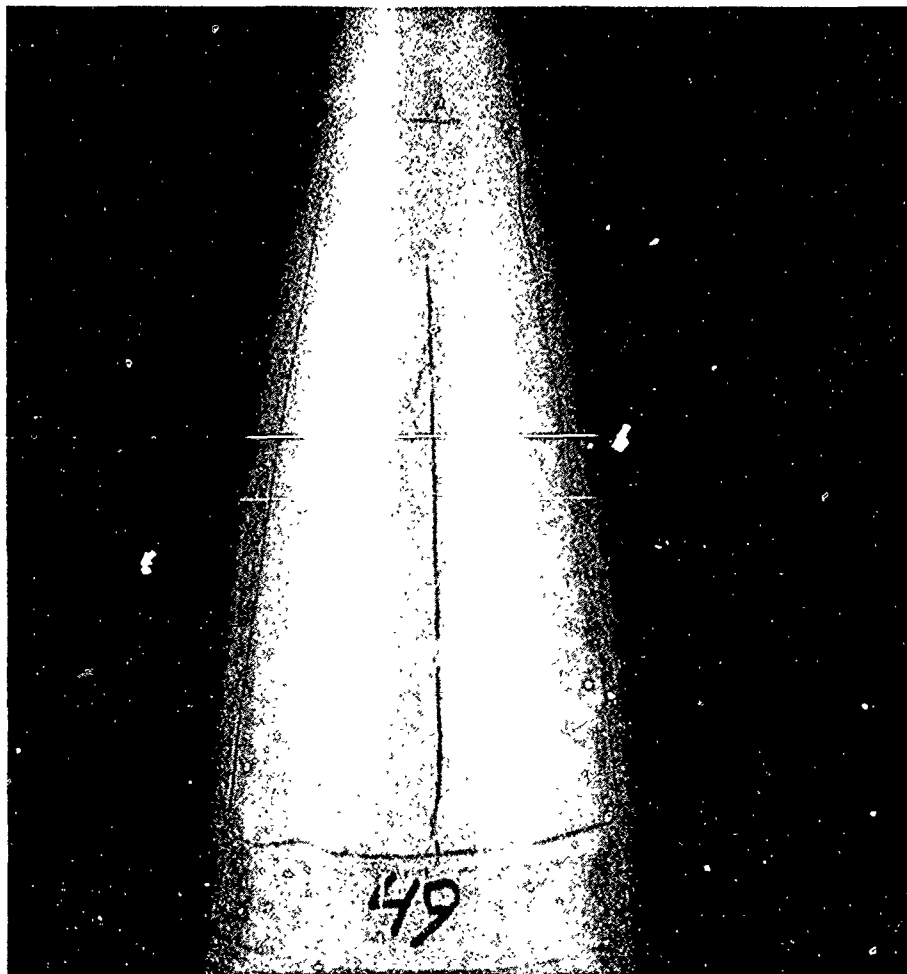


Figure 10. SAAP test sample 49; coating: CR/EP/AE

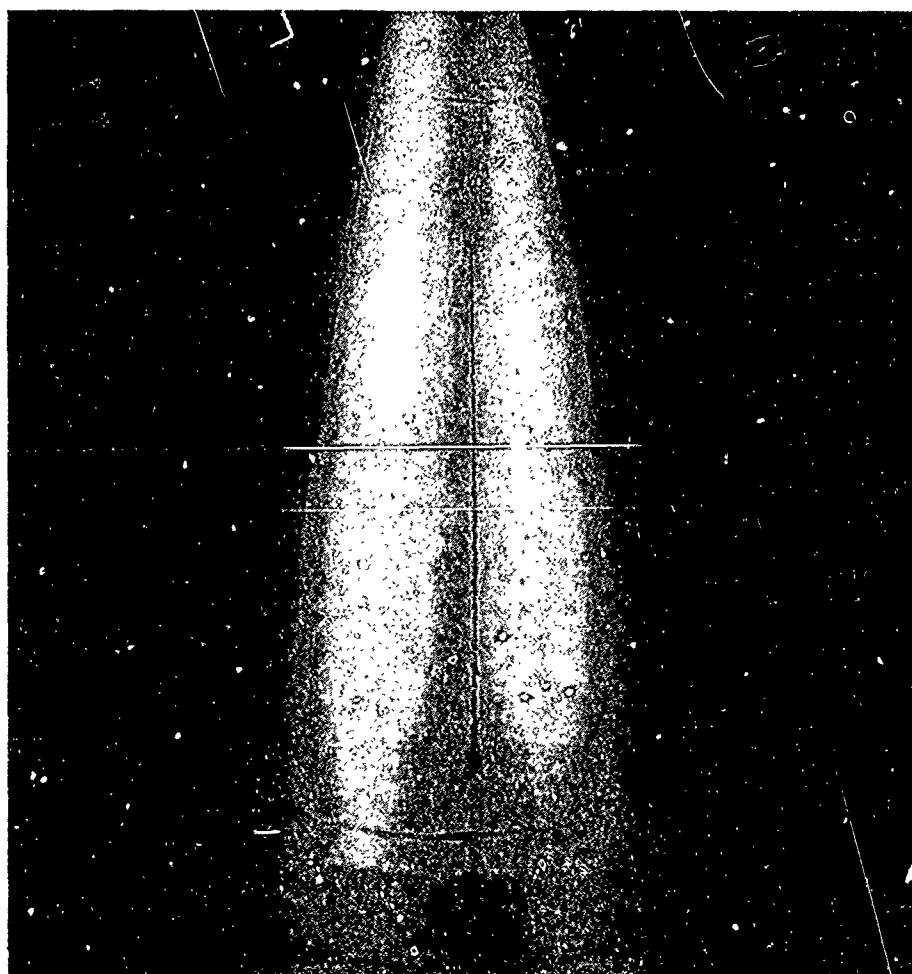


Figure 11. SAAP test sample 54; coating: NCR/EP/AE

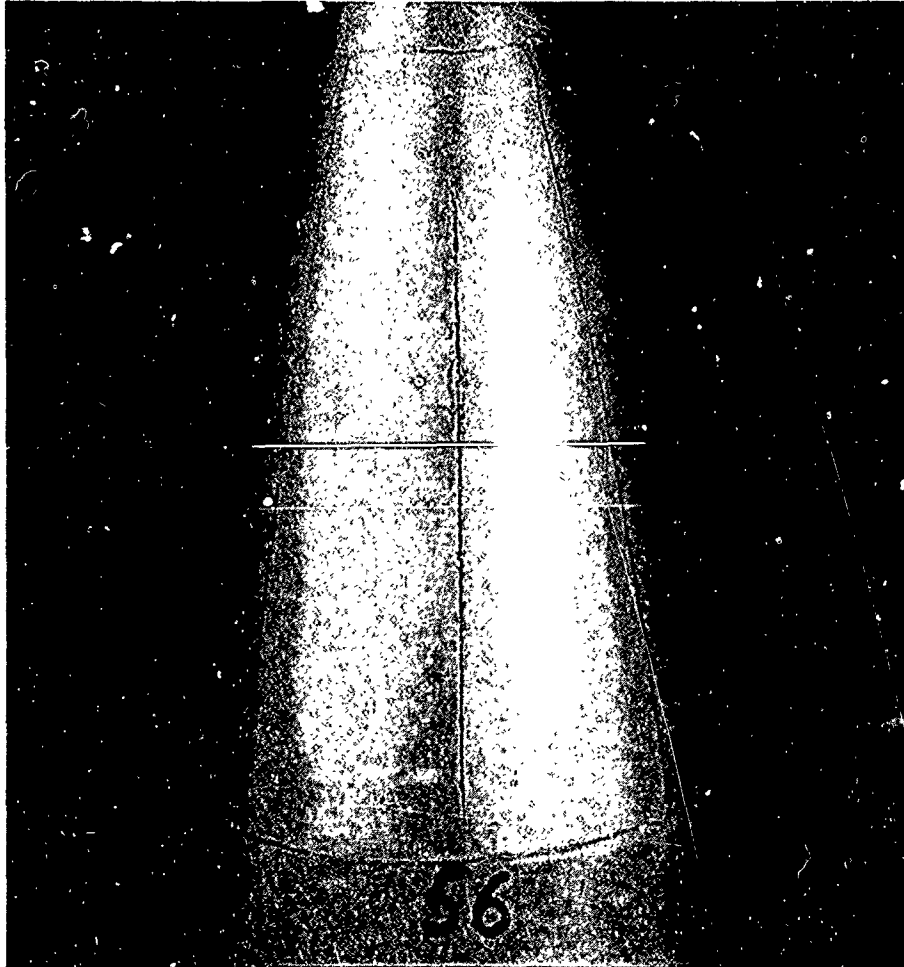


Figure 12. SAAP test sample 56; coating: NCR/EP/AE

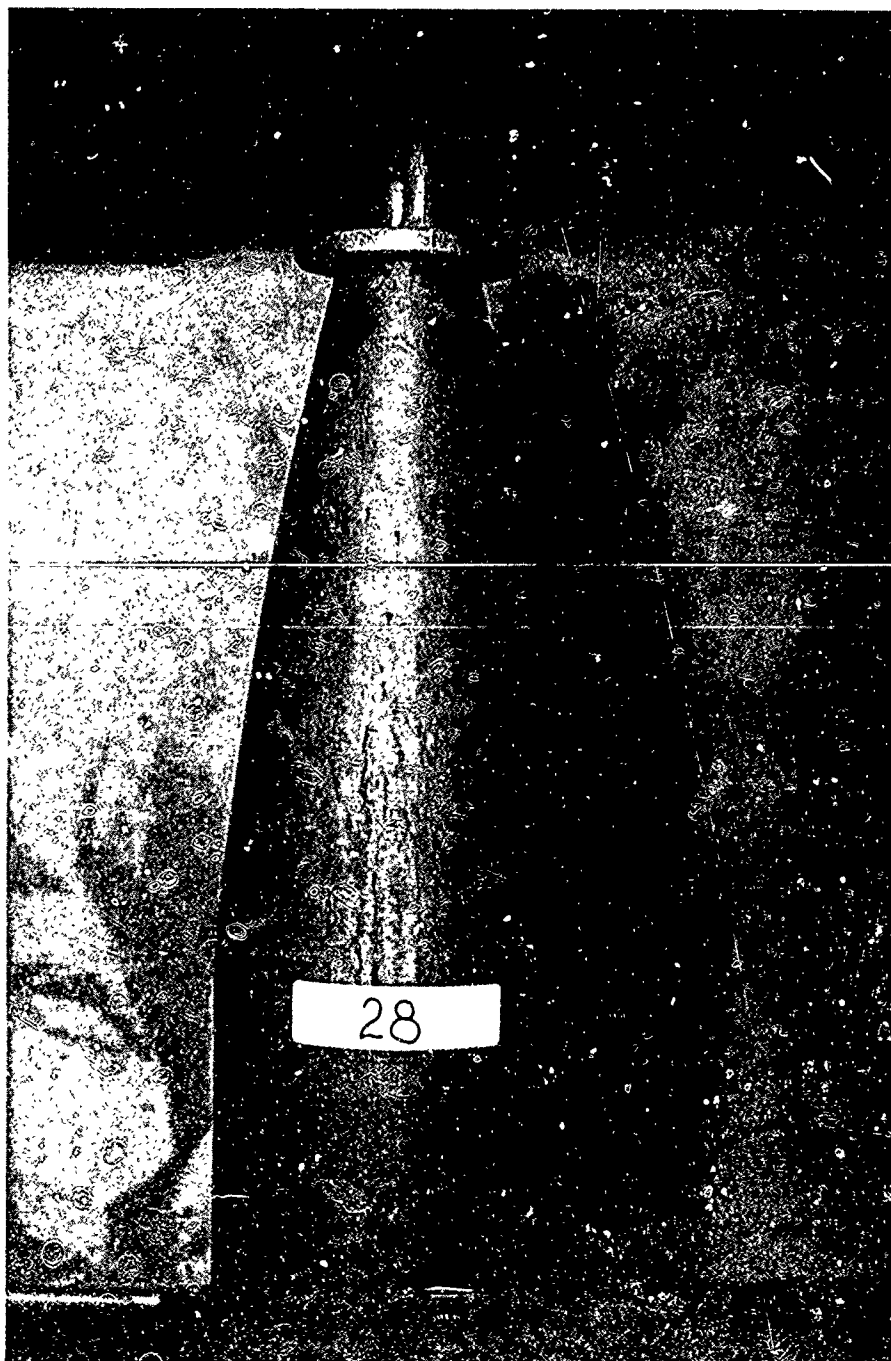


Figure 13. ARDEC test sample 28; coating: CR/WP/AE

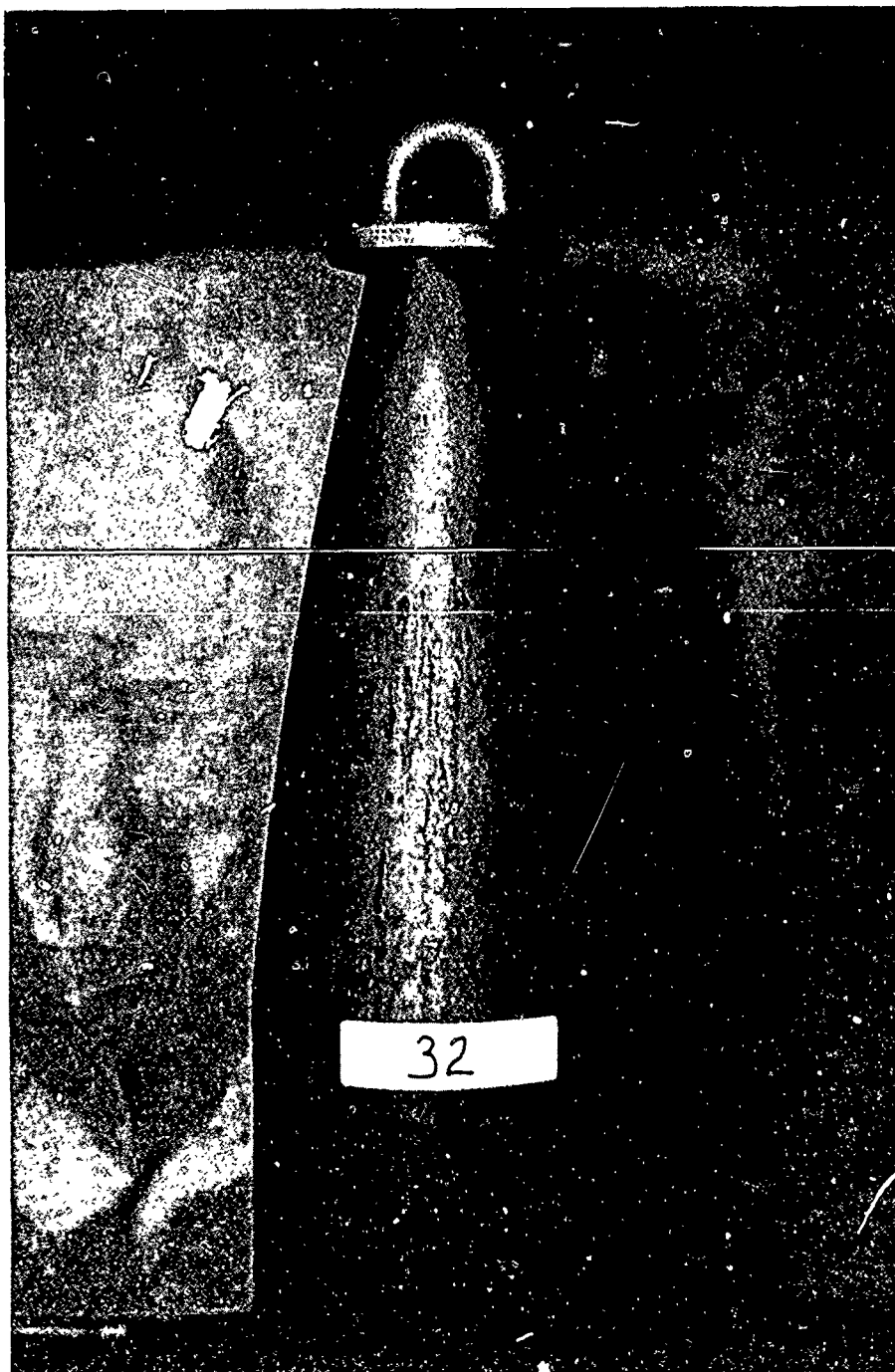


Figure 14. ARDEC test sample 32; coating: NCR/WP/AE

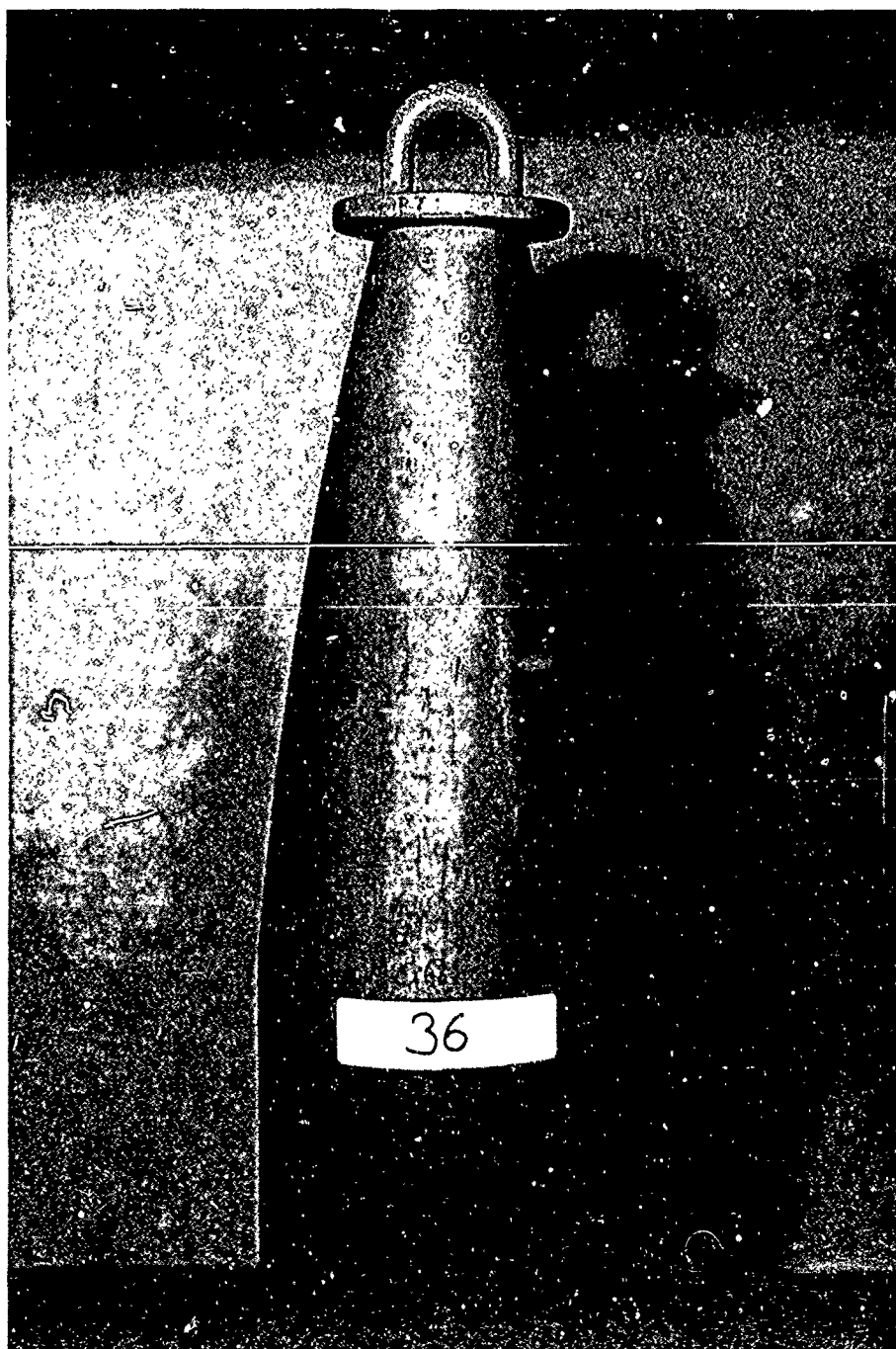


Figure 15. ARDEC test sample 36; coating: NCR/WP/AE

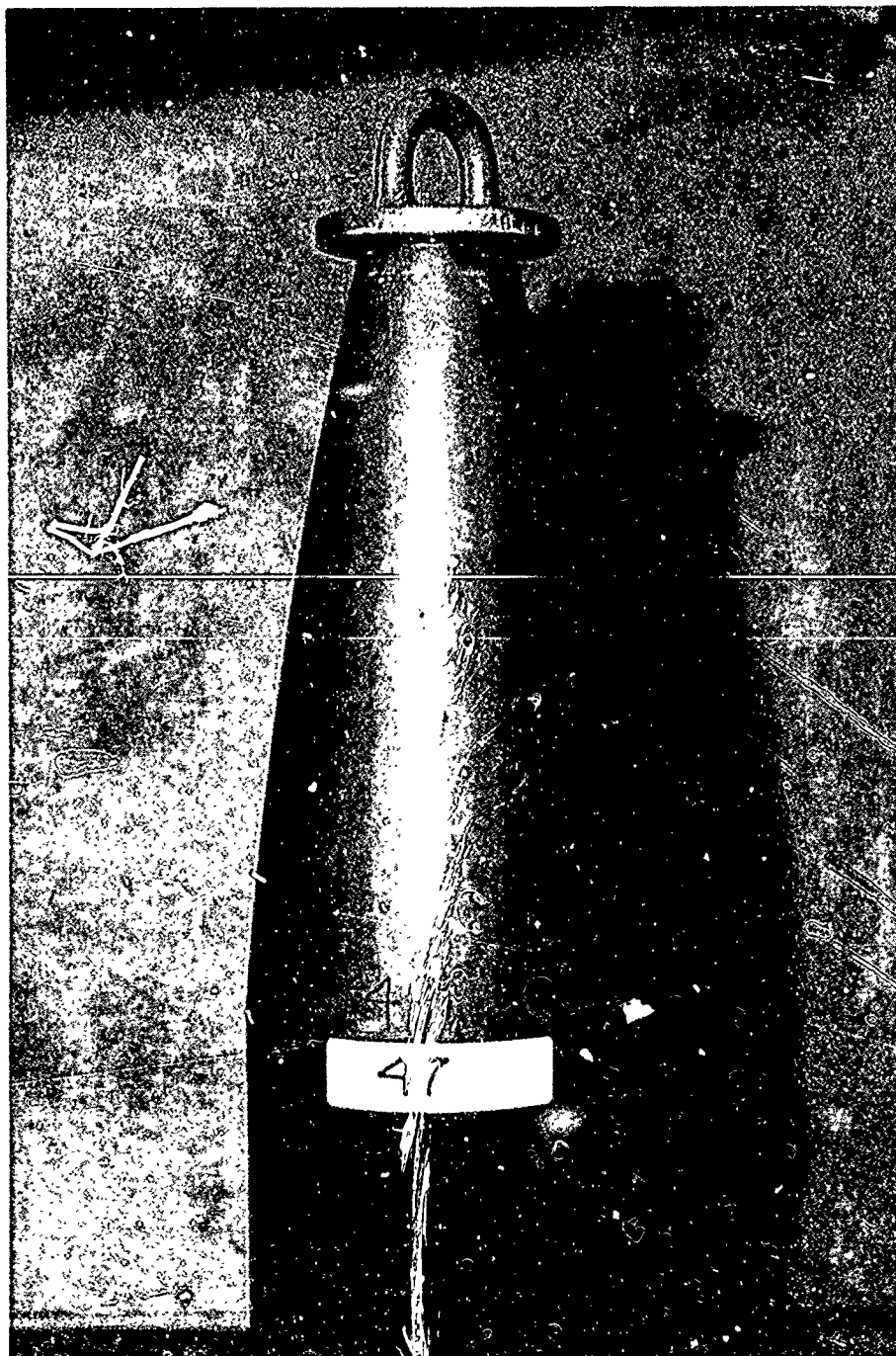


Figure 16. ARDEC test sample 47; coating: CR/EP/AE

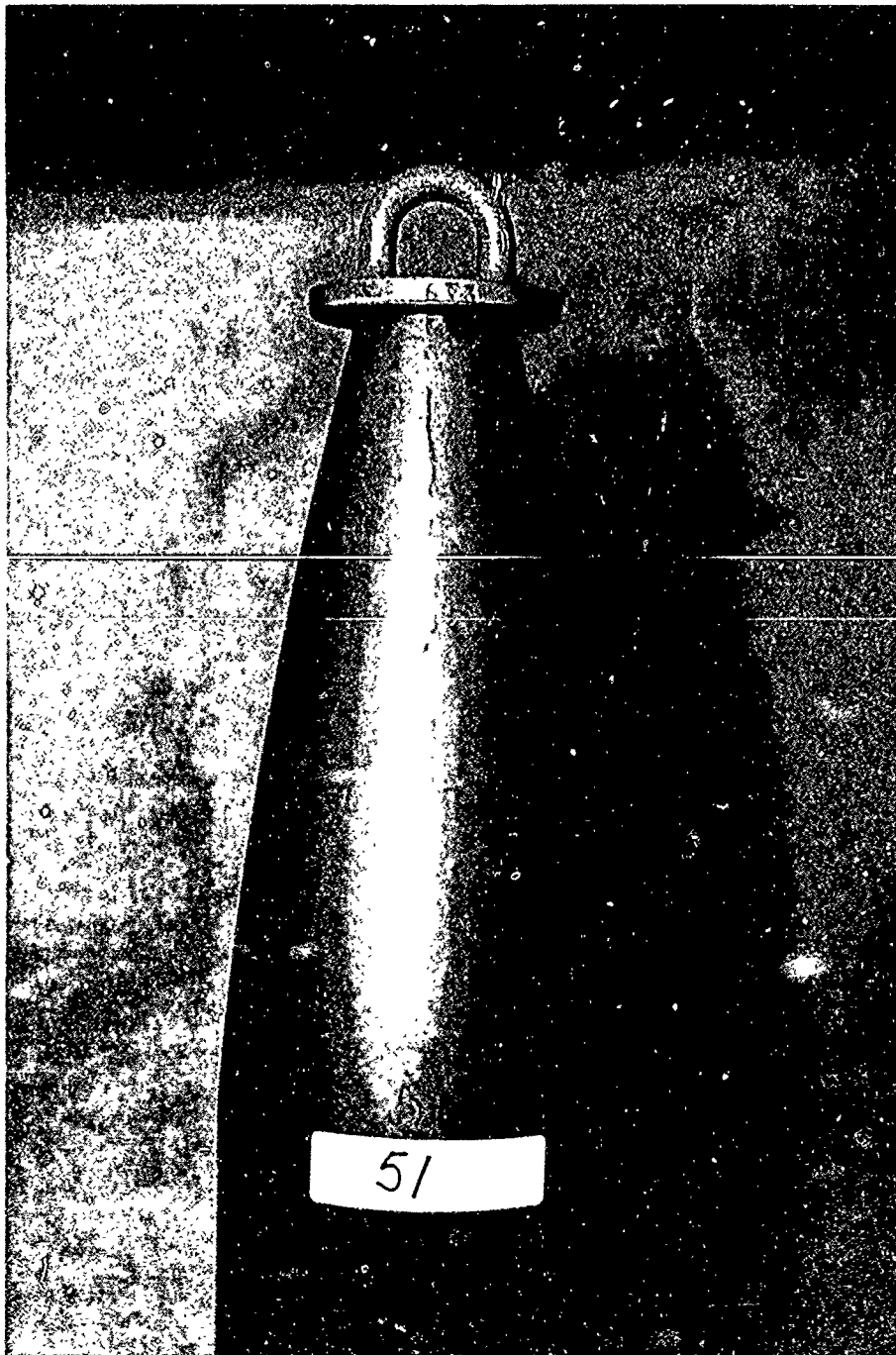


Figure 17. ARDEC test sample 51; coating: NCR/EP/AE



## GLOSSARY

AE	Alkyd enamel (MIL-E-52891)
AMC	Army Materiel Command
ARDEC	Armament Research, Development and Engineering Center
ASTM	American Society for Testing and Materials
CARC	Chemical agent resistant coating
CR	Chrome rinse
CMC	Chamberlain Manufacturing Corporation
DFT	Dry film thickness
EAMTP	Environmentally acceptable materials, treatments, and processes
EP	Epoxy prime (MIL-P-53022)
F	Fahrenheit
GOCO	Government-owned, contractor-operated
HAZMIN	Hazardous minimization
IAW	In accordance with
MANTECH	Manufacturing Technology Program
MSD	Material safety data
MTL	Material Technology Laboratory
NCR	Nochrome Rinse
OCRC	Ocean City Research Corporation
ppm	Parts per million

SOW	Scope of Work
TC	Total coating thickness (prime and top coatings)
TDP	Technical data package
SAAP	Scranton Army Ammunition Plant
TDS	Technical data Sheet
WP	Wash Prime (DOD-P-15328)

## **APPENDIX A**

### **TDS and MSD FOR OAKITE ULTRA-RINSE**

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# PRODUCT PROFILE

OAKITE PRODUCTS, INC., 50 VALLEY ROAD, BERKELEY HEIGHTS, N.J. 07922  
 OAKITE PRODUCTS OF CANADA, LTD., 115 EAST DR., BRAMALEA, ONT. L6T 1B7  
 Subsidiaries and Distributors World-wide Cable: OAKITE, Berkeley Heights

## TECHNICAL DATA

**OAKITE CRYSCOAT, ULTRA RINSE:** Non-chromated final alkaline rinse for specific Oakite CryscCoat iron and zinc phosphating processes; matches the performance of final chromated rinses without the use of pollution-causing chrome

## PRIMARY APPLICATION

A mildly alkaline liquid, new Oakite CryscCoat Ultra Rinse is a chrome-free, final sealer/rinse for phosphate coatings on steel, aluminum and galvanized steel. It achieves chrome-like results as the final rinse for CryscCoat 547 and CryscCoat 947 (iron phosphates) as well as CryscCoat FG, MP and LWT (zinc phosphates).

The no-rinse, prepaint treatment quickly washes away unwanted, unreacted phosphate residues that could interfere with the adhesion of subsequently applied paints. At the same time, CryscCoat Ultra Rinse reacts with the phosphated metal surface to enhance its paint-bonding property and improve its corrosion-resisting ability under subsequently applied paint. It also inhibits flash rust before painting.

Without the use of polluting chrome (no costly disposal problem), CryscCoat Ultra Rinse closely matches the corrosion resistance of similar systems that use a final chromated rinse. This is substantiated in extensive salt spray tests. Finally...metal finishers have a non-chromic rinse that really works like it's chromic.

What's more, CryscCoat Ultra Rinse has a bath life 3 to 5 times longer than that of other chrome-free final rinses. The phosphate-free material is also free of heavy metal salts. Most important, it's compatible with a wide range of modern paint systems.

## CHEMICAL CHARACTERISTICS

Oakite CryscCoat Ultra Rinse is a liquid alkaline blend of scientifically selected constituents in a proprietary formulation for which a patent has been applied. The yellow liquid is a low to moderate foamer and should not be used at high pressures in a spray washer.

## APPLICATION PROCEDURE

Application must be preceded by fresh water rinse stage. This should be overflowing through the use of a fresh water riser at the end to prevent contamination of the CryscCoat Ultra Rinse stage with dirty rinse water. Never apply CryscCoat Ultra Rinse in washers that do not use a fresh water riser at the end of the preceding rinse stage.

Oakite CryscCoat Ultra Rinse is used in the final rinse stage of the tank or spray phosphating process at 1.0 to 2.0% by volume, room temperature to 60°C (140°F), 1/2 minute, pH 8.0 to 10.0. Apply at low pressure (5 to 12 psi) in spray washers. Use dry-off oven or air dry. Use forced air to remove moisture from pockets or cavities.

**Solution Control:** Concentrations are titrated using Test Kit Procedure TK 125. The Sample Volume is 5 ml and Multiplying Factor (F) is 4.0. The procedure below may also be used.

### Water Blank

1. Measure a 50-ml sample of the water used to make-up a bath into a beaker or a flask.
2. Add 3 to 5 drops of bromocresol green (Oakite Indicator 5).
3. Titrate with 0.1N HCl (Oakite Testing Solution 2) until the solution turns from blue to yellow. Record this result as Titration A.

### Operating Bath

1. Measure a 50-ml sample of the operating bath into a beaker or a flask.
2. Add 3 to 5 drops of bromocresol green (Oakite Indicator 5).
3. Titrate with 0.1N HCl (Oakite Testing Solution 2) until the solution turns from blue to yellow. Record this result as Titration B. Control Calculation.  $(\text{Titration B} - \text{Titration A}) \times 0.4 = \% \text{ by volume Oakite CryscCoat Ultra Rinse.}$

### Conductivity

1. Check the conductivity of the bath on fresh bath make-up with a total dissolved solids meter.
2. Check the conductivity on a daily basis.
3. Make up the bath fresh once the daily conductivity reading exceeds the fresh reading by 266 ppm (400 micromhos). If these readings are not exceeded, dump once every 2 to 3 weeks. Clean completely before recharging.

## NOTES ON USE—See Material Safety Data Sheet

Mild steel equipment and heating coils may be used.

Before using CrysCoat Ultra Rinse for the first time in a spray washer or immersion tank, steps must be taken to insure that all scale and residue from any preceding treatment is removed. Dump the stage and remove all loosely adherent scale and residue. Remove all residue from floor of tank. Fill tank 80% full with water and add 10% Oakite 360 L. Heat to 66° to 71°C (150° to 160°F) and circulate for 3 to 4 hours or until the tank or spray washer is clean. Dump, flush, and refill with water. Circulate, dump and flush. Refill with fresh water to charge with Oakite CrysCoat Ultra Rinse.

Aerate immersion tanks continuously, and spray tanks when not in use.

**Safety and Handling Precautions:** Oakite CrysCoat Ultra Rinse is an alkaline industrial product. Do not get in eyes, on skin or clothing. Wear rubber gloves, safety goggles or face shield, and other suitable protective clothing when handling. Do not take internally.

**First Aid in Case of Contact:** For **eyes**, immediately flush thoroughly with plenty of water for at least 15 minutes. Get medical attention. For **skin**, immediately wash thoroughly with plenty of water for at least 15 minutes. If irritation develops, get medical attention. Remove contaminated clothing and shoes and wash before reuse. If **ingested**, contact local Poison Control Center or physician **IMMEDIATELY!**

**KEEP OUT OF REACH OF CHILDREN.**

## DISPOSAL

Dispose of according to all federal, state and local regulations.

## PACKAGING

Packaged inside poly containers in fiber drums of 208 liters (55 U.S. gallons) and 76 liters (20 U.S. gallons).

## SHIPMENT

May be shipped by any common carrier. Freight classification is "Compound Cleaning Liquid, Corrosive Material—NA 1760." Product Code No: 3670.

## STORAGE

Store in a cool dry area. Keep container tightly closed when not in use. **KEEP FROM FREEZING.**

effect of high temperature storage	no adverse effect
effect of low temperature storage	freezes at 0°C (32°F); will reconstitute on warming to 21°C (70°F) with stirring
effect of aging	no adverse effect



3670

**MATERIAL SAFETY DATA SHEET**

PRODUCT CODE: 3670  
OAKITE CRYSCOAT ULTRA RINSE  
27-RL-20

HMIS 1 2 0 B

**SECTION I**

TRADE NAME	OAKITE CRYSCOAT ULTRA RINSE	EMERGENCY TELEPHONE NUMBER:
CHEMICAL NAME AND SYNONYMS	NA; Mixture	(800) 424-9300 (CHEMTREC)
MANUFACTURER'S NAME AND TELEPHONE NO:	OAKITE PRODUCTS INC. (201) 464-6900 (8am-5pm)	
ADDRESS	50 Valley Road Berkeley Heights NJ 07922	

**SECTION II - HAZARDOUS INGREDIENTS**

	CAS NO.	% BY WT	TLV	PEL	UNITS
Trade secret registry (735517)	-5062P	<10	NE	NE	
Ethyl alcohol	0000064175	<10	1000	1000	ppm
Non-hazardous ingredients		Bal.			

Mixture is not considered a health hazard under Federal Hazard Communication Standard (29 CFR 1910.1200).  
It is a physical hazard due to flash point.

Primary skin and eye animal tests have been performed according to the requirements under 16 CFR 1500.41-1500.42 (See Section V).

**SECTION III - PHYSICAL DATA**

BOILING POINT (F)	NE	SPECIFIC GRAVITY (H2O=1)	1.008
VAPOR PRESSURE (mm Hg)	NE	Bulk Density	
VAPOR DENSITY (Air=1)	NE	PERCENT VOLATILE	
SOLUBILITY IN WATER	Complete	BY VOLUME(%) Excludes H2O	<10
EVAPORATION RATE (BuAc=1)	<1	PH @ 40 g/l	10.0

NA - Not Applicable

NE - Not Established



APPEARANCE AND ODOR	Colorless liquid; amine odor.	Concentrate	10.5
---------------------	-------------------------------	-------------	------

#### SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method Used): 136 F (PMCC)  
FLAMMABLE LIMITS: LEL: NE UEL: NE

**EXTINGUISHING MEDIA:** Carbon dioxide, dry chemical, or foam.

**SPECIAL FIRE FIGHTING PROCEDURES:**      **Wear Self-Contained Breathing Apparatus (SCBA).**

**UNUSUAL FIRE AND EXPLOSION HAZARDS:** Closed containers may explode when exposed to extreme heat.

## SECTION V - HEALTH HAZARD INFORMATION

<b>ROUTE(S) OF ENTRY:</b>	<b>INHALATION:</b>	<b>SKIN:</b>	<b>INGESTION:</b>
	X	X	X

**MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:** None known

**SYMPTOMS/EFFECTS OF OVEREXPOSURE:**

Primary skin and eye animal testing has shown that symptoms and/or effects of overexposure are absent when using this product.

## FIRST AID

**EYES:** Flush eyes with plenty of water.

**SKIN:** Wash affected area with large amounts of water.

**INGESTION:** Contact local poison control center or physician IMMEDIATELY!

INHALATION: NA

## SECTION VI - REACTIVITY DATA

**STABILITY:      NORMALLY STABLE**

Keep away from heat, sparks, open flame.

**INCOMPATIBLE MATERIALS:** Strong acids; Strong oxidizers.

HAZARDOUS DECOMPOSITION PRODUCTS: Carbon monoxide, Carbon dioxide.

NA - Not Applicable

NE - Not Established



3670

**MATERIAL SAFETY DATA SHEET**

## =====

**SECTION VII - SPILL OR LEAK PROCEDURES**

PROCEDURES: Wear personal protective equipment (See Section VIII).  
Ventilate area. Remove all heat and ignition sources. Clean up with  
inert absorbant material.

WASTE DISPOSAL METHOD: Dispose of in accordance with Local State and Federal  
regulations.

## =====

**SECTION VIII - SPECIAL PROTECTION INFORMATION**

RESPIRATORY: Not normally required.

EYEWEAR: Wear chemical safety goggles.

CLOTHING/GLOVES: Wear neoprene or other chemical-resistant gloves as necessary  
to prevent prolonged or repeated skin contact.

VENTILATION: Local exhaust may be necessary for some handling/use  
conditions. Specific needs should be addressed by  
supervisory or health/safety personnel.

## =====

**SECTION IX - SPECIAL PRECAUTIONS**

Store in closed container in cool well-ventilated area. COMBUSTIBLE. Keep away  
from heat, sparks, open flame. This product does not contain any carcinogens  
(at 0.1% or greater) as defined by IARC, NTP, or OSHA.

APPROVAL

Health &amp; Environmental Dept.

05/01/1990

NAME

TITLE

DATE

NA - Not Applicable

NE - Not Established

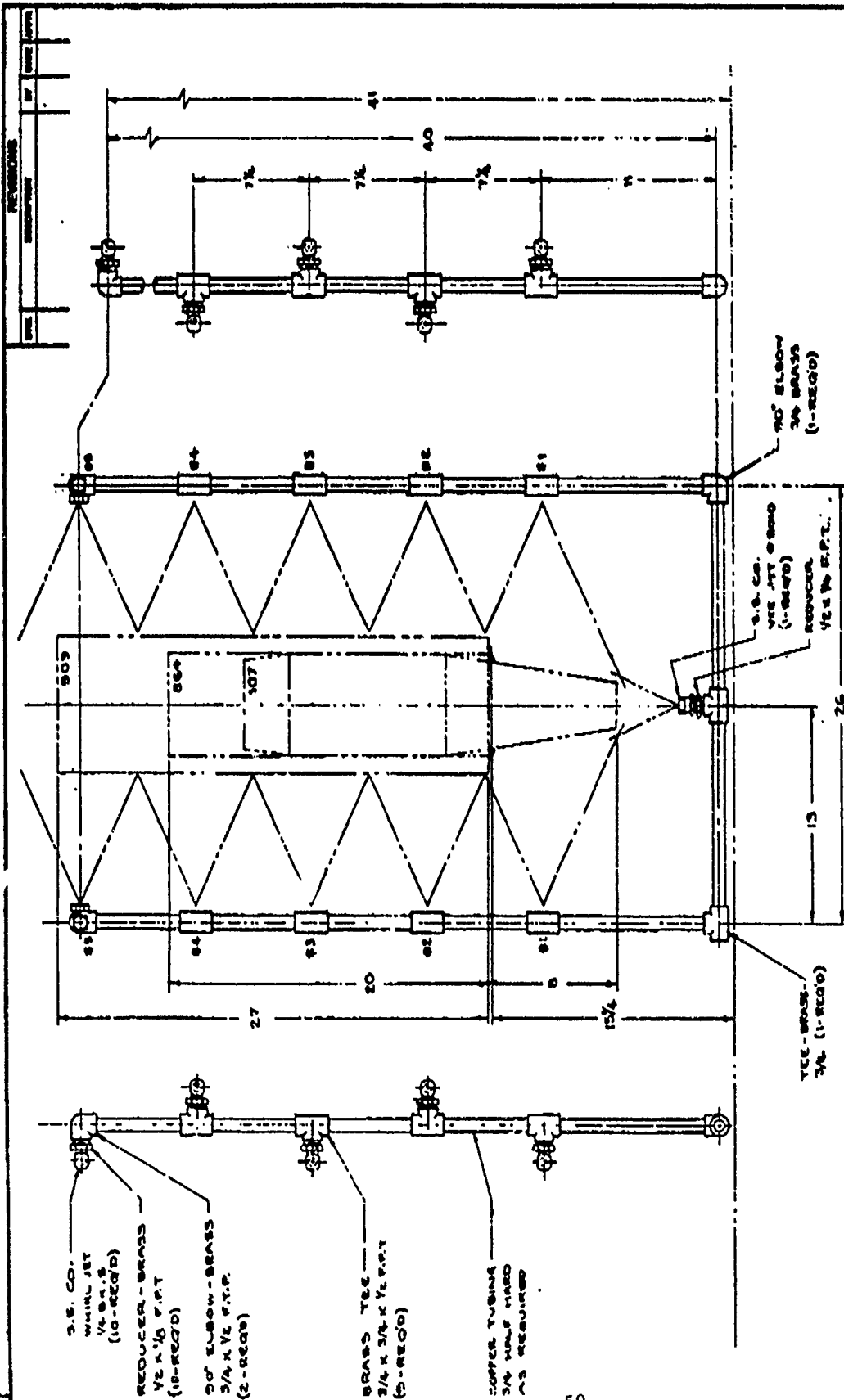
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## **APPENDIX B**

### **FRESH WATER RINSE**

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USE NOZZLES SHOWN WHEN RINSING SHELL AS DESIGNATED

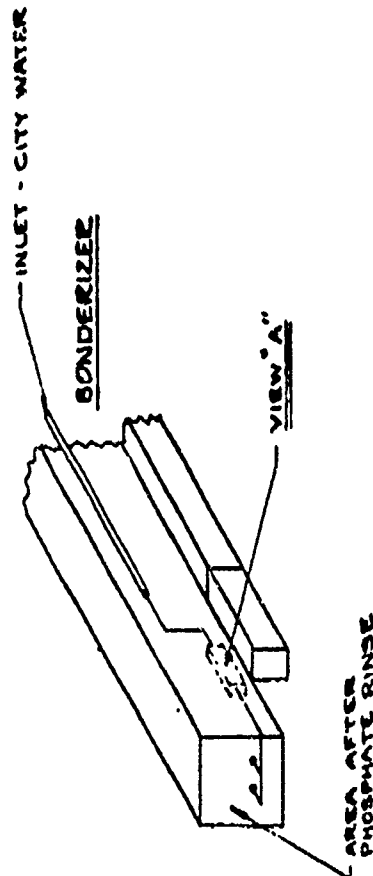
SHELL	NOZZLE
509	# 2, 3, 4 & 5
107	# 1, 2 & 3
964	# 1, 2, 3 & 4
906	# 1, 2, 3 & 4

PROJ: 580 NON-CHROME RINSE

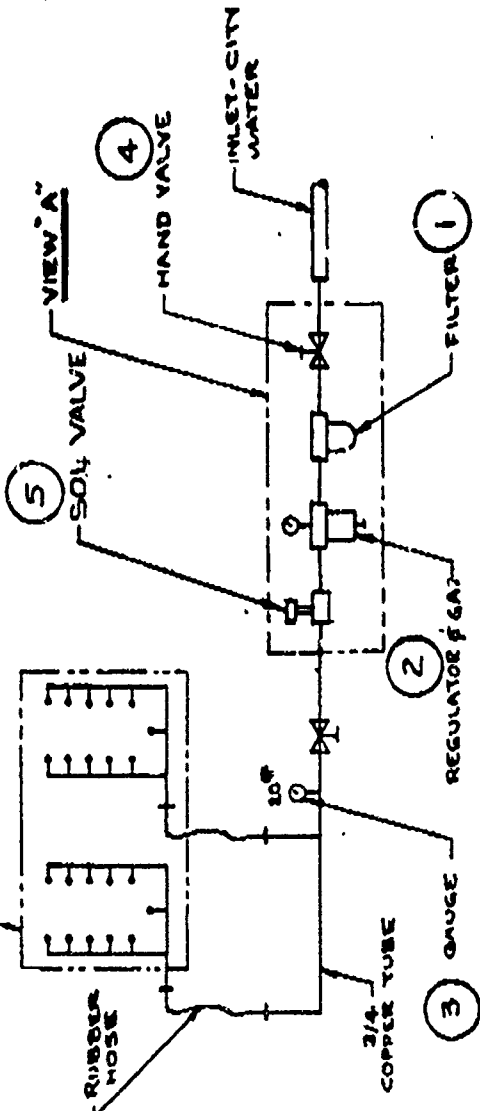


COLD WATER RINSE (NON-CHROME)	
NO.	580
REV.	0000-59-35-109

REVISIONS			
REV.	DESCRIPTION	BY	DATE
A	REMOVED AREA AFTER PHOSPHATE RINSE - GAUGES & VALVES	FOR	2-20-71
B	ADDED ITEM #5	FOR	2-20-71



AREA AFTER  
PHOSPHATE RINSE  
REF. DWG. 0000-59-35-109



ITEM	QTY	DESCRIPTION	REMARK
5	1	SOLV. VALVE	ASCO EP8210694-H20NC
4	2	GATE VALVE	1/2" PIPE THD.
3	2	GAUGE 0-100"	11438-73 SPRAYING SYS
2	1	REGULATOR	11438-252 SPRAYING SYS
1	1	LIQUID STRAINER	1/2" TUB-SS-50 SCREENING SYS.
ITEM	QTY	DESCRIPTION	REMARK
<b>Chamberlain</b> Chamberlain Manufacturing Corporation A Unit of Ingersoll-Rand Inc.			
COLD WATER RINSE BONDERIZER #124#3			
REV.	DATE	BY	DATE
1	2-20-71	FOR	2-20-71
2	2-20-71	FOR	2-20-71
3	2-20-71	FOR	2-20-71
4	2-20-71	FOR	2-20-71
5	2-20-71	FOR	2-20-71



Fresh water rinse at SAAP

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## **APPENDIX C**

### **OPERATING DATA FROM BONDERIZERS II and III**

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# OPERATING DATA

M-107	BONDERIZER # 2		DATE: 12-21-90		TIME: AM	
	PT (ml.)	TEMP	PH	TA	FA	TA/FA RATIO
Cleaner Tank #1	1.2 oz/gal.	175°F				
Hot Rinse Tank #2		150°F				
Phosphate Tank #3		180°F	2.5	13	2.3	5.7/1
Cold Rinse Tank #4		125°F		% By Volume		PPM
Non-Chrome Rinse #5		125°F	9.2			
				1.46		126

E. Salitsky

Set-Up Man Signature

CC-INSP. #62

M107

Rev #35 10/11/91

Panel Weight 186 milligrams per square foot.

# OPERATING DATA

M- 107	BONDERIZER # 3	DATE: 12-21-90	TIME: AM			
	PT (ml.)	TEMP	PH	TA	FA	TA/FA RATIO
Cleaner Tank #1	$1.3 \times 1.4 = 1.8$ oz/gal.	140°F				
Hot Rinse Tank #2	0.21	140°F				
Phosphate Tank #3		155°F	2.6	23	3.5	6.6/1
Cold Rinse Tank #4		100°F				
Chrome Tank #5		130°F		4	1	4/1

F. Salitsky  
 \_\_\_\_\_  
 Set-Up Man Signature

CC-INSP. #62

6/11/90

Panel Weight 205 milligrams per square foot

## DISTRIBUTION LIST

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U.S. Army Armament, Munitions and Chemical Command

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AMSMC-PBC-A, M. Wrazen (3)  
AMSMC-PBC-A, G. Kosteck (1)  
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Chamberlain Manufacturing Corporation  
Scranton Division  
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Scranton, PA 18505

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Scranton Army Ammunition Plant  
ATTN: SMCSC-CA, A. Pisano  
136 Cedar Avenue  
Scranton, PA 18505

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Rock Island, IL 61299-6000

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Oakite Products, Incorporated  
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Berkeley Heights, NJ 07922

Parker-Amchem  
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Madison Heights, MI 48071

Ocean City Research Corp.  
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Tennessee Avenue & Beach Thorofare  
Ocean City, NJ 08226

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U.S. Army Material Technology Laboratory  
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SLCMT-MEE, K. Bamberg  
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Warren, MI 48397-5000

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U.S. Army Armament Munitions and Chemical Command  
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Arlington, VA 22202

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Corpus Christi, TX 78419

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Champaign, IL 61826

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Riverbank, CA 95367-0670

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McClellan Air Force Base  
Air Force Logistics Command  
TI-5  
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Sacramento, CA 95652-5000

NI Industries  
Riverbank Army Ammunition Plant  
ATTN: S. Luquire  
5300 Claus Road, PO Box 856  
Riverbank, CA 95367-0856

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United Technologies Corp.  
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Stratford, CT 06802

Action Metal Processing Corp.  
ATTN: J. Thim  
47 Athletic Field Road  
Waltham, MA 02154

Valentec Wells  
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3190 Pullman Street  
Costa Mesa, CA 92626